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January, 1922

The Commonwealth of Massachusetts

DEPARTMENT OF AGRICULTURE

Dr. ARTHUR W. GILBERT, Commissioner
136 STATE HOUSE, BOSTON

THE UTILITY OF BIRDS

SECOND EDITION, REVISED

DIVISION OF ORNITHOLOGY

EDWARD HOWE FORBUSH, Director

BOSTON
WRIGHT & POTTER PRINTING CO., STATE PRINTERS
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A Monument to Sea Gulls.

Western gulls saved from death by starvation the first Mormon settlers in Utah. This monument was erected in Salt Lake City by the grateful people, at an expense of $40,000, to commemorate the event. (From Bird-Lore. See page 21.)

EXCHANGE

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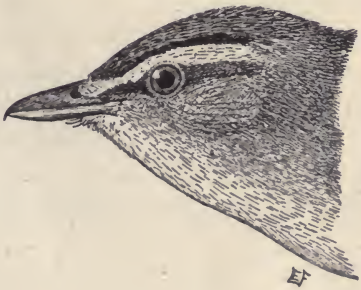

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CONTENTS.

PAGE

Introduction, ... 5

The Function of Birds in Nature, ... 7

Utility of Insect-eating Birds, ... 14

Quantity of Insects eaten by Young Birds, ... 18

Quantity of Insect Food required by Adult Birds, ... 19

Crops and Trees saved from Destruction by Birds, ... 20

Decrease of Birds followed by Increase of Destructive Insects, . . 37

Increase of Birds followed by Decrease of Destructive Insects, . . 42

Birds as Weed Destroyers, ... 45

Birds as Distributors and Planters of Seeds, ... 46

Birds as Scavengers, ... 47

Utility of Birds of Prey, ... 47

Services rendered by Shore Birds, Marsh Birds, Waterfowl and Sea Birds, . 53

Cash Value of Birds' Services, ... 60

Utility of Birds in War, ... 63

Commercial Value of Birds, ... 64

Early Abundance of Game Birds, ... 65

Game Birds as Food, ... 65

Eggs of Sea Birds as Food, ... 69

Feathers of Sea Birds and Wild-fowl for Bedding, ... 70

Feathers for Ornament, ... 72

Shooting Birds for Sport, ... 75

Value of Birds in Domestication, ... 76

Fertility from the Sea — Immense Value of Guano Deposits, . . 77

Esthetic, Sentimental and Educational Value of Birds, ... 80

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THE UTILITY OF BIRDS.

Introduction.

There is a continual demand for literature setting forth the usefulness of our native birds. In the introductory chapter to my "Useful Birds and their Protection" the subject of the utility of birds in nature was treated at some length, but as that work, having passed through several editions, is now out of print, it seems necessary to treat the subject briefly as an introduction to this bulletin, so that the reader, as a necessary preliminary before examining the evidence regarding the value of birds to man, may realize something of their function in nature.

Our globe teems with life. Uncounted myriads of plants and animals encompass the earth, dwell in the sea, or float upon the invisible waves of the atmosphere. Earth's animals and plants vary in size from that of the infinitesimal atom, too small for the human eye to discern through the most powerful microscope, up to that of the mighty whale, 90 feet in length, and the great sequoia of California, 325 feet high, or the giant eucalyptus of Australia, reaching a height of 470 feet.

Let one examine carefully a few square yards of grassland in summer and see how many individuals of plant and animal life he will find.[1] Let him look thoroughly over the bark of a single tree and note how many insect species are living on or under it. During a few hours of one July night off the Maine coast we saw in the dark, flashing waters myriads of fish limned in phosphorescent light darting away from the prow of our vessel. For 10 miles we plowed through their countless, never-ending hordes, apparently all of one size and one species, and no one knows how much farther their hosts extended. Yet we could not have seen them at all but for the light produced by the countless millions of Noctilucæ which illumined every moving thing in those waters. The numbers of these tiny animals have been estimated at 30,000 to each cubic inch. How many of these atomies, representing only one form of life, existed in that sea through which those millions of fish were swimming?

[1] Mr. W. L. McAtee found 1,254 individual forms of insects and other small animal life, and 3,113 seeds on 4 square feet of meadow land (Science, New Series, Vol. XXVI, No. 666, Oct. 4, 1907, p. 447).

The number of species of living animals and plants on the earth is vast, and the number of individuals entirely beyond human comprehension. The chief efforts of every individual of each species go to preserve its life and to produce seed or offspring and so multiply its kind, but always and everywhere similar efforts of the many other organisms by which each species is surrounded tend to hold its multiplication in check. Huxley says that if there were but a single plant in the world, and that plant should produce but fifty seeds each year and multiply unchecked, its progeny would cover the globe in nine years. The oak produces quantities of acorns. Were each seed to develop into a tree the earth in time would be covered with oaks, and all other trees would be crowded out. But many mammals, birds and insects feed on acorns and so prevent their germination; others feed on the seedling trees and destroy bark, leaf and wood, so that on the average each mature oak during all the years of its long life succeeds in producing but one other to live and take its place. The fulmar petrel, so says Darwin, lays but one egg, yet it is believed to be the most numerous species of bird in the world. Wallace estimates that the unchecked increase of any pair of birds having four young each year would amount to 2,000,000,000 birds in fifteen years. However, such an enormous multiplication never happens because snakes, turtles, crows, hawks, jays, squirrels, raccoons, cats, foxes and many other creatures eat birds or their eggs or young. Many birds are destroyed by the elements; they are starved, frozen and drowned, and their increase is checked so that commonly in nature but one pair of birds succeeds another.

In the insect world the possibilities of unchecked increase are still more formidable than among mammals or birds. Huxley reckons that the young of a certain plant louse, increasing unchecked, in one year would equal in bulk the entire human population of the Chinese Empire. Such increases in number, however, are impossible because of the many forces always working to check them. Insects in all their forms are killed and eaten continually by a host of other creatures.

Each animal species while striving mightily to increase its numbers also works to hold others in check. Forbes likens the whole system of life with all its interrelations to a series of ex-

panding and contracting springs, each of which in expanding is checked, pushed back or compressed by others. The moment one weakens and becomes slightly contracted others expand to fill the vacancy. When one expands unduly, others exert increased force to contract it again; for example, when locusts become unduly numerous and devastate the land, practically all wild beasts and birds neglect other foods and consume locusts until the latter again become reduced in numbers. All the forces of Nature are thus balanced one against another. Plants and trees produce foliage and seed enough to feed all living animals, some of which take their food direct from plant life, while others get it wholly or in part at secondhand by devouring insects or other animals which feed on plants.

We may say, then, that in the economy of Nature all species are useful, since all have their part in preserving that general balance and stability which works for the good of all life.

The Function of Birds in Nature.

The chief value of birds in the general plan lies in the great part that they have in maintaining this biologic balance, — a part that cannot be filled by other creatures. Like many other organisms they are ordinarily rather impartial of choice regarding food, and they forage wherever and on whatever is best for the common welfare. Nevertheless, birds exercise some choice and fill a special place. Their position in one respect is unique. Their structure fits them to perform a certain function, — that of a swiftly moving body of police, adapted to sweep rapidly over the surface of the earth and assemble quickly in hosts wherever most needed to combat abnormal outbreaks or irruptions of animal life.

A swarm of grasshoppers appears, and birds from far and near concentrate upon them. A plague of field mice occurs, and birds descend upon them from the four quarters of the land. This facility of movement renders birds serviceable, also, in clearing the earth of offensive decaying animal matter, for many are scavengers. Quantities of fish are cast upon the shore, and thousands of sea birds come sweeping in from wide waters and far shores to devour them. Vultures gather from afar to

destroy the decomposing carcasses of the animals slain by some pestilence. Birds are particularly fitted to perform such services in Nature (1) by their wonderful power of flight, (2) by their remarkable vision, (3) by their great capacity for consuming and assimilating food, and (4) by their propensity to wander.

Birds excel all other creatures in powers of flight. The arctic tern migrates annually from the arctic regions to the Antarctic Ocean. The tiny ruby-throated hummingbird flies from Hudson Bay to Panama. The semi-annual migrations of birds over the northern hemisphere enable them to explore every part of each continent over which they pass, and to exert a periodic repressive influence upon all living creatures on which they feed, — first in their northern homes, next in migration over the temperate zone, and last in the southern lands, where they winter and where they reënforce the numbers of resident birds, most of which migrate little if at all. The highly developed flight-powers of birds enable them to overtake and destroy both winged and wingless creatures amid the foliage of plants, on the surface of the earth, in the air, and even in and under the water into which many birds can readily dive and in which many can both swim and fly. Birds, like insects, can quickly reach from the air all external parts of plants, and they are especially formed and adapted for the pursuit of insects.

Birds find distant food mainly by their almost telescopic sight. Thus warblers high in air discern others far below engaged in the act of feeding, and seeing this they drop from the sky and join the busy throng. Thus, too, the vulture, floating aloft on level pinions, discovers food in the valley below, and circling downward is seen by others in the distant skies; as they turn to follow him they also are observed by others still, and so the tidings spread until at last a great assemblage of these feathered scavengers concentrates at the fatal spot.

The muscular power exhibited by birds, their high temperature, the extremely rapid circulation of the blood, and their remarkable activity compel them to eat a tremendous amount of food to repair the constant waste of their tissues. The enormous capacity of birds for assimilating food can be appreciated by those only who have studied the subject. When food is plentiful birds gorge themselves. So rapid is the digestion of

the smaller insectivorous birds that they are able daily to consume and assimilate quantities of insect food enormously beyond their apparent capacity.

When one begins to study the food of birds he finds that exceedingly complex food relations exist between the bird and the animals and plants on which it feeds. The food preferences of a bird may produce complicated, far-reaching and unexpected results. It is not often possible for the investigator who studies a bird's food to measure fully the effect of its feeding habits. In ordinary circumstances a tent caterpillar and a climbing cutworm both would be considered destructive, as both are known to consume the foliage of trees, but when we find the climbing cutworm destroying the living pupæ of the tent caterpillar moth, it seems questionable at first sight whether the bird that eats both is rendering any valuable service in nature. Likewise, when we find birds feeding on tiny parasitic insects which kill injurious insects by living and feeding within their bodies, or when we see birds destroying the larger predaceous insects which kill and eat so-called injurious insects, we are inclined to wonder whether birds when engaged in destroying such beneficial creatures are not themselves injurious.

Let us examine the effect of this practice among birds. First, it should not be forgotten that the chief function of birds is to perform their part in holding in check the whole great body of insect life, and to help in preventing its undue increase. Therefore, since birds are helping to hold in check all insect life, their reduction of what we call beneficial insects is a negligible harm, if they are at the same time reducing in greater measure the numbers of the far more numerous injurious insects. Man's own measures to control pests (as by spraying) destroy many useful parasitic and predaceous insects; but spraying is not thereby condemned. Under normal conditions birds and other predatory enemies of insects are of chief importance. Parasitic insects, though often performing remarkably efficient service, are ordinarily of secondary value for the following reason: birds and other predatory enemies of insects destroy their prey at once, while most parasites allow the insect pests to continue injurious activity until the latter have nearly or fully passed their feeding period. The parasite, therefore, in

case of an irruption of an insect pest does not usually destroy the pest until the injury has been done; it only prevents another generation. Birds and other predatory enemies, on the other hand, kill the pest at once, and so prevent both immediate and later injury.

Professor F. E. L. Beal, who probably examined the contents of more birds' stomachs than any other scientist of his time, says, "That birds are an efficient check upon insect multiplication seems impossible of denial, and it is doubtful if anywhere else in the animal kingdom any other restraining influence so important can be found." [1]

We must understand that birds in Nature are neither mere beneficent organisms, working solely for the good of the human race, nor injurious enemies of mankind; but that as a whole they form a regulative body doing their part in keeping a wholesome balance amongst the forces of Nature for the benefit of all. To illustrate in some measure the food relations of birds and the manner in which food preferences react, the following, somewhat revised, is taken in substance from my "Useful Birds and their Protection:" —

Eagles, large hawks and owls feed to some extent on crows, and probably the nocturnal, tree-climbing, nest-hunting raccoon also robs crows of eggs and young; otherwise they seem to have very few natural enemies to check their increase. Crows feed on so many different forms of animal and vegetable life that they are nearly always able to find an abundance of suitable food; therefore they are commonly and widely distributed.

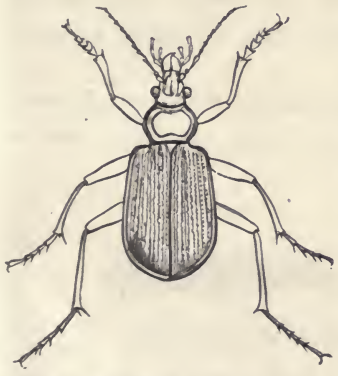
The general fitness of the crow is admitted by all. Undoubtedly it has a useful work to perform in the world. But a careful study of its food habits shows so many apparently harmful traits that it may well leave the investigator in some doubt regarding the crow's value in the general plan. Crows rob the nests of robins, eating very many eggs and young birds; therefore they constitute a serious check on the increase of robins. Robins feed largely on common black beetles, called ground beetles (Carabidæ). As these beetles are not quick to fly by day and may be easily caught, they form a considerable

[1] Beal, F. E. L.: The Relation between Birds and Insects, Yearbook, United States Department of Agriculture, 1908, p. 344.

part of the food of many ground-frequenting birds. But ground beetles feed to a greater or less extent on other insects. The question then arises, is not the robin doing harm by eating ground beetles, and does it not merit the destruction of its eggs and young by the crow? If the robin's habit of eating these beetles is harmful, is not the crow rendering a service by destroying a bird apparently so injurious as the robin? If there were too many robins might they not eat too many ground beetles and thus become the indirect cause of the destruction of much vegetation by saving the lives of the caterpillars and other harmful insects that the ground beetles, had they been spared, might have destroyed? [1]

A ground beetle ordinarily useful, but injurious if in excessive numbers, eaten by the robin.

Many ground beetles that are eaten by the robin feed much on vegetable matter.[2] This makes these beetles doubly useful in one respect, for they can maintain their numbers when insect food is not plentiful, and so be ready to check any increase of insects which may occur. On the other hand, if they become too numerous they may do serious damage by destroying grass, grain or fruit. I have witnessed attacks made by certain of these beetles on grain and strawberries, and were they not held in check by birds they might become serious pests. Their destruction by robins and other birds tends to keep these beetles within those normal bounds where they



Calosoma scrutator, useful ground beetle, eaten by crows.

[1] These questions can be answered only by one having a thorough knowledge of the food of our ground beetles, — a knowledge which no living man yet possesses; but enough has been learned to throw some light on their food habits. Insects that feed promiscuously on other insects are regarded as beneficial in so far as they take insect food, even though they may destroy many so-called useful insects; for, as the injurious insects far outnumber the useful species, any check upon the general increase of insect life must result in a balance of good.

[2] The predaceous beetles of one genus (Calosoma) and those of some closely allied genera are exceptions to this rule, and are believed to feed entirely on animal food, as their structure fits them for that alone. They feed ravenously upon both beneficial and injurious insects, and when abnormally numerous they devour one another. These beetles, however, are eaten by crows and probably not by robins.

will do the most good and the least harm, while the check kept by the crow on the increase of the robin may prevent the latter from destroying too many ground beetles. If certain low-feeding caterpillars should become so numerous as to be injurious, ground beetles and robins would feed largely on them. The caterpillars would then largely take the place of the beetles in the robin's diet. The beetles therefore would increase in numbers, and the force of both bird and beetle would be exerted to reduce the caterpillars to harmlessness. This accomplished, the robins would again attack the ground beetles, and thus tend to reduce them to normal numbers.

Let us now go back to the beginning of our chain of destruction. Eagles, hawks, owls and raccoons may indirectly swell the numbers of the robins by limiting the increase of the crow. But hawks and owls also prey on the robin, and by dividing their predatory activities between robin and crow assist in keeping both birds to their normal numbers. Whenever crows become rare, robins as a consequence would become very numerous, were it not that hawks also eat robins. (Hawks and owls also eat some species of insects that are eaten by both robin and crow.)

There are compensations in the apparently detrimental career of the crow. An omnivorous bird, it takes any food that is

Cutworm moth and its caterpillar, eaten by robins, crows and other birds.

plentiful and easily obtained. It is a great feeder on May beetles (miscalled "June bugs"), the larvæ of which, known as white grubs, burrow in the ground and sometimes devastate grasslands, and also injure the roots of many other plants, including trees.

The crow is also a destroyer of cutworms, which are the young or larvæ of noctuid moths or "millers" such as are commonly seen fluttering from the grass by any one who disturbs them when walking in the fields. Robins also feed

largely on cutworms, as well as on the white grubs of the May beetle. When these insects are few in number, a part of the usual food supply of both robin and crow is cut off. This being the case, the hungry crows would be likely to destroy more young robins and other young birds than usual in order to make up the supply of animal food for themselves and their ravenous nestlings. This, again, would decrease perceptibly the number of robins and other small birds, and would be likely in turn to allow an increase of May beetles and cutworms. Should these insects become more plentiful, the crows would naturally turn again to them, neglecting the young of robins and other birds for a time, and allowing them to increase once more, until their multiplication put a check on the insects, when the crows would of necessity again raid the robins.

The blue jay may be taken as another instance of this means of preserving the balance of Nature. Hawks and owls kill blue jays, and crows destroy their eggs and young; thus the blue jays are kept in check. Jays are omnivorous feeders. They eat the eggs and young of other birds, particularly those of warblers, sparrows and vireos, — birds which are active caterpillar hunters. But jays themselves are extremely efficient caterpillar killers. They atone in great measure for destroying other caterpillar-eating birds when they (the jays) turn to killing caterpillars which have increased in numbers in consequence of the destruction by jays of eggs and young of smaller birds. Like the crow, they virtually kill the nestlings of the smaller birds and eat them that they (the jays) may eventually have more insect food for their own young. When this object has been attained the jays may perhaps again allow an increase of the smaller birds, the survivors of which they have indirectly furnished with more insect food, thus making conditions favorable for their increase. These oscillations, or alternate expansions and contractions, in the numbers of birds or insects often are so slight as to escape common observation. It is only in those cases where the alternations are carried to extremes that they result disastrously. Under Nature the checks on the increase of birds are essential, else birds would multiply until their food supply became exhausted, when they would starve, and other consequences much more complex and more serious to mankind would quickly follow.

While the above statement of the way in which the balance of Nature is preserved may be regarded as somewhat hypothetical, probably it approximates what actually takes place, although the feeding habits of birds undoubtedly produce far more complicated and far-reaching results than are outlined here.

It is a law of Nature that the destroyer is also the preserver. Birds of prey benefit the species on which they prey in at least two ways not noted above: (1) the more powerful bird enemies of a certain bird usually prey also upon some of the weaker enemies of that bird; (2) these powerful birds also check the propagation of weakness, disease or unfitness by killing off the weaker or most unfit individuals among the species on which they prey, as these are most easily captured.

We have seen already that jays, which are enemies of the smaller birds, are preyed upon by the more powerful crows, hawks and owls. These latter also destroy skunks, weasels, squirrels, mice and snakes, all of which are foes of the smaller birds. No doubt these animals would be much more destructive to the smaller birds were they without these wholesome feathered checks on their increase.

Utility of Insect-eating Birds.

Practically all birds eat insects, and it is among insects that we find the most destructive pests known to man. Most plant-eating insects that live in or about cultivated lands or forests are potentially injurious. Some when kept normally repressed by their natural enemies may feed only on noxious plants commonly called "weeds," and so may be harmless or even beneficial; but let the checks upon their increase become lessened in any way, so that their natural food supply becomes insufficient for their increasing numbers, and they may at once menace growing crops. Any plant-eating insect that increases much beyond its normal numbers soon assumes the importance of a pest, and all insects have this tendency to multiply.

Insect pests are particularly destructive, not only because of their large numbers but also because of their great consumption of food. A certain maggot consumes in twenty-four

hours two hundred times its original weight.[1] The food taken during fifty-six days by a caterpillar of *Telea polyphemus* equals in weight eighty-six thousand times the original weight of the caterpillar when first hatched from the egg. This enormous voracity accounts for the excessive destructiveness of insects when in abnormal numbers. It explains in part why the yearly injury caused by insects to agricultural and forest products in the United States exceeds $1,000,000,000.

Fortunately the appetites of birds closely match those of insects. A single polyphemus caterpillar may eat 120 oak leaves during its lifetime. But the birds destroy nearly all these caterpillars and so the species rarely becomes numerous enough to be injurious.[2] Samuels says that Trouvelot, to test the effectiveness of birds, placed 2,000 of the polyphemus caterpillars on a tree near his door, and in a few days the birds had eaten them all.[3]

In 1861 Trouvelot began his attempt to produce silk from American silkworms. He experimented at Medford, Massachusetts, for several years, and from 1864 to 1870 he raised the larvæ of *Telea polyphemus* in large numbers. It was about 1869 that, in the course of his importations of European insects for experimentation, he introduced and accidentally liberated the gypsy moth which has proven a very destructive and expensive pest. For six years or more he reared polyphemus caterpillars in astonishing numbers, having over five acres of shrub oak and other bushes fenced in and covered with netting for this purpose. He found birds by far "the most formidable enemies of the caterpillars," and he tells us that birds came from far and near to destroy them. The smaller birds forced themselves through the meshes of the net, and the larger ones found holes through which they were able to enter, and he was "obliged to chase them all the day long, as when pursuing them on one side they would fly to the other," and feed until he reappeared.[4]

Samuels tells us that Trouvelot was obliged to shoot many birds, especially robins; that he never found any fruit in the

[1] Lintner, J. A.: Sixteenth Annual Report, New Jersey State Board of Agriculture, 1888-89, p. 295.

[2] Trouvelot, Leopold: The American Silk Worm, American Naturalist, Vol. 1, 1867, pp. 85, 89, 145.

[3] Samuels, E. A.: Birds of New England, 1870, p. 156.

[4] Trouvelot, Leopold: American Naturalist, Vol. 1, 1867, pp. 89 and 145.

stomachs of these birds, but only insects; and that he concluded that if the birds were killed off all vegetation would be destroyed by insects.[1] Here we have the chief reason why the huge caterpillars of polyphemus, cecropia and luna moths, which are capable of doing immense damage, rarely become numerous enough to be noticeable. When the settlers on our great western plains first began to plant trees to provide windbreaks on the prairies they introduced the eggs or cocoons of large moths on the young trees. As there were no tree birds then in the region, the larvæ of the larger moths, such as polyphemus and cecropia, multiplied exceedingly, making it almost impossible to grow trees, but as groves and orchards finally became established, and arboreal birds spread over the country, nesting and rearing their young in the trees, these caterpillars were reduced to comparatively harmless numbers.[2]

Dr. Robert T. Morris of New York City wrote me on December 7, 1917: —

> My own special hobby is the hybridizing of nut trees upon my country place at Stamford, Connecticut. In order to do this work I cover branches carrying pistillate flowers with large paper bags in order to protect the flowers from any pollen except that which I wish to introduce. These bags commonly remain in place two or three weeks. The leaves are not removed from the branches, but are tucked into the paper bags. I found that under the protection of these bags insects increased to such an extent that they sometimes destroyed all the leaves, and almost always destroyed or injured so many of them that the branches which had been covered stood out distinctly from the rest of the tree all summer long. It was necessary for me to resort to the plan of dusting the leaves thickly with Persian insect powder, or spraying them with Pyrox before enclosing them in the bags.

Of course the bags excluded from the branches so covered not only birds but other natural enemies of insects. Nevertheless, any attempt by man to protect or propagate insects for any purpose soon demonstrates that birds are very potent and persistent enemies of those insects. Mr. E. P. Felt, working under my direction, in the year 1891, confined numbers of gypsy moth caterpillars in bags of netting stretched over the limbs of

[1] Samuels, E. A.: Birds of New England, 1870, p. 156.

[2] Useful Birds and their Protection, Massachusetts State Board of Agriculture, 1907, pp. 109, 110.

SAMIA CECROPIA, MOTH AND CATERPILLAR.
This insect, potentially a terribly destructive tree pest, is rendered nearly harmless by birds.

apple trees. It was found almost impossible to complete the experiments, as very many caterpillars were taken from the nets by birds. I saw a chipping sparrow break through the nets and secure a large caterpillar. More than 50 species of birds feed on such hairy larvæ, and Mr. Felt noted that 60 per cent of the caterpillars used in these experiments were taken by birds which broke into the nets.[1]

Quantity of Insects eaten by Young Birds.

Fortunately the young of insectivorous birds grow almost as rapidly as many of the insects on which they feed. Most of the young of the smaller birds are well grown and able to fly in from one to three weeks after they leave the egg. This rapid growth calls for a tremendous amount of animal food. A young robin fed by Professor D. Treadwell made no gain in weight until the fourteenth day, when it received 68 angleworms. Later the same bird consumed in a day nearly one-half its own weight of beef. A young man eating at this rate would consume about 70 pounds of steak daily.[2]

Mr. C. W. Nash fed a young robin daily for fifteen days from 50 to 70 cutworms or earthworms. By experiment he found that it would eat 165 cutworms in a day.[3]

Mr. A. H. Kirkland kept and fed some young crows. His records show that on less than 8 ounces of food daily one bird tended to lose in weight, and only when the food was increased to 10 ounces was there a marked tendency toward a daily gain. The digestion of many young birds is so rapid that the stomach is emptied of food in from twenty minutes to two hours, according to the character of the food eaten.

Mr. F. H. Mosher watched two red-eyed vireos feeding young, and found that in ten hours the parents together brought food to the nest one hundred and twenty-five times.[4]

Professor Aughey states that during a locust year in Nebraska he saw a pair of long-billed marsh wrens in an hour take 31

[1] Forbush, E. H., and Fernald, C. H.: The Gypsy Moth, Massachusetts State Board of Agriculture, 1896, pp. 215, 216.

[2] Treadwell, D.: Proceedings of the Boston Society of Natural History, Vol. 6, pp. 396-399.

[3] Birds of Ontario in their Relation to Agriculture, Ontario Department of Agriculture, Bulletin No. 218, p. 64.

[4] Useful Birds and their Protection, Massachusetts State Board of Agriculture, 1907, pp. 45–52,

small locusts to their young, and a pair of rock wrens took in another hour 32 locusts to their nest.[1]

Dr. C. M. Weed and Mr. W. S. Fiske watched the nest of a chipping sparrow from 3.40 A.M. to 7.49 P.M.[2] The birds made almost 200 trips to the nest in that time. They were busy from daylight to dark, and the food so far as identified consisted largely of caterpillars.

Quantity of Insect Food required by Adult Birds.

The constant activity of adult birds is such that they require an enormous quantity of food to repair the waste of the tissues. Mr. Robert Ridgway fed a pet Arkansas kingbird 120 grasshoppers in a single day.[3] Those who examine the contents of birds' stomachs find in them the remains of astonishing numbers of insects. Professor Beal says that oftentimes when a stomach has been opened and the contents placed in a pile, the heap expands until it becomes two or three times as large as the stomach was originally with all the food in it. He found in the stomach of a yellow-billed cuckoo remains of 217 fall webworms, and in another, 250 tent caterpillars. Sixty grasshoppers were found in the stomach of a nighthawk. Professor Harvey told me that he took 500 mosquitoes from another nighthawk's stomach. Dr. Judd says that the stomachs of four bank swallows contained 200 ants, and that a nighthawk has been known to eat 1,000 at a single meal. In the stomach of a Franklin's gull there were 70 entire grasshoppers and the jaws of 56 more; in another, 90 grasshoppers and 102 additional jaws; in another, 48 grasshoppers and 70 jaws.[4]

Some estimates of the quantities of insects eaten by birds in different States of the Union have been made, and as the figures are very conservative the results in brief are given below. The birds of Massachusetts destroy 21,000 bushels of insects daily (estimated) (Reed); the birds of Pennsylvania, 2,880,000,000 insects daily (Kalbfus); and the birds of Nebraska, 170 carloads each day (Bruner). These figures may

[1] Aughey, S. A.: Notes on the Nature of the Food of Nebraska Birds, First Report of the United States Entomological Commission, 1877, Appendix, p. 18.

[2] Bulletin No. 55, New Hampshire College Agricultural Experiment Station, 1898.

[3] American Naturalist, Vol. III, 1869, p. 310.

[4] Useful Birds and their Protection, 1907, pp. 57–61.

serve to give some idea of the great influence that birds exert on the prevalence of insect life.

The remarkable appetites of birds serve to make them signally useful when they destroy our insect enemies, but proportionately harmful when they feed on grain, fruit or other crops. The chief crop injuries attributable to birds occur when, during migration, birds gather excessively in one locality. To utilize in full the services of birds, and to minimize the losses that they cause, we should adopt toward them the policy of the natives of India, who refrain from killing birds, but use ingenious devices to frighten them away from fields of ripening grain. It may be necessary at times to kill birds to protect crops or poultry, but such birds in New England as are commonly more injurious than beneficial may be counted on the fingers of one hand.

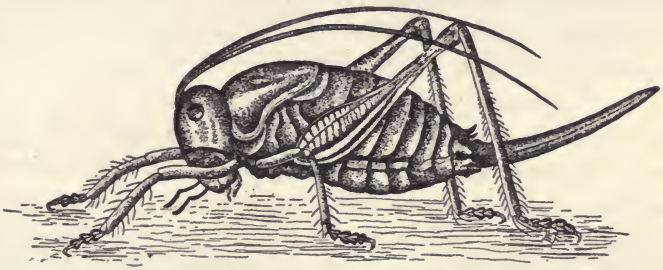
Crops and Trees saved from Destruction by Birds.

The principal service of birds to agriculture consists in the prominent part that they play perennially in the control of insect pests. Modern agriculture, both intensive and extensive, produces great crops of the same food plants year after year on the same or contiguous tracts, thus occasioning an excessive multiplication of the insects that feed on those crops. Other crop-destroying insects are introduced from foreign lands. Meanwhile the birds that feed upon them are destroyed by farmers, gunners, boys, cats, dogs and other enemies or agencies introduced by man, while their nesting places are broken up and their natural food plants destroyed by the operations of agriculture. Under these circumstances we need not wonder that the numbers of birds often are insufficient fully to cope with our greatly increased insect enemies; or that, deprived of their natural food, birds attack grain or fruit. Frequently it becomes very evident that birds are not sufficiently numerous to keep insect pests in check. Nevertheless, they suppress insect outbreaks more often than is generally known. By increasing their numbers we may render them still more effective.

In presenting the following accounts of the suppression of insect invasions by birds, one cannot always guarantee the

accuracy of the observations recorded, but the testimony is taken from what seem to be reliable sources.

Among the Orthoptera, which includes the grasshoppers and crickets, farmers will recognize some of the most destructive insects of the fields. Practically all birds feed on grasshoppers and locusts, and many on crickets, and it is largely due to this habit that these insects are not oftener seriously destructive. There is an historical occurrence regarding the early settlement of Utah by the Mormons which illustrates the value of birds as destroyers of Orthoptera. When the Mormons established their earliest settlement in Utah, their first crops were almost destroyed by myriads of black crickets, so called, that came down from the mountains. These orthopterous insects have been identified as the so-called "western cricket" (*Anabrus purascens*). The crops of the first year having been destroyed, the Mormons were in severe straits, but they had seed to sow for the second year. The grain promised well, but again the crickets appeared, coming down from the mountains in swarms. The Honorable Geo. Q. Cannon stated that they came down by millions and destroyed the grain crops. Promising fields of wheat were cut down to the ground in a single day. The people were in despair. Then sea gulls came by hundreds and thousands, and, before the grain could be entirely destroyed, devoured the insects, so that the fields were freed from them.[1]



THE "WESTERN CRICKET."
Its hordes, while devastating the crops of the Mormon settlers, were in turn destroyed by gulls.

[1] See Irrigation Age, 1894, p. 188; Insect Life, Vol. VII, p. 275; Annual Report, Massachusetts State Board of Agriculture, 1871, p. 76; Annual Report, United States Commissioner of Agriculture, 1871, p. 79; and Second Annual Report, United States Entomological Commission, 1878–79, p. 166.

The settlers regarded this as a heaven-sent miracle, and there stands to-day at Salt Lake City a monument costing $40,000 to commemorate the event. (See frontispiece.)

Among the most persistent enemies of grasshoppers we must count crows. There was a tremendous outbreak of these insects in Australia in the spring of 1894. Dr. N. A. Cobb of the Department of Agriculture, Sydney, New South Wales, tells of the immense good done by crows in the Mossvale district in destroying the pest. For weeks crows were very abundant throughout this region. Dr. Cobb made an effort to estimate the number. Armed with a telescope he mounted one of the highest hills and found that the crows were about equally distributed over the land. He estimated that the Mossvale district at that time was supporting not less than one-quarter of a million crows, and it was his belief that the actual number was much greater than this estimate. He found that the crows were feeding almost entirely on grasshoppers. By examining a large number of stomachs he became satisfied that each crow's stomach contained at that time nearly if not quite 100 grasshoppers. He assumed that the stomach of each crow was filled twice a day. (Any one who has ever attempted to keep a crow from starvation will realize that this was a very moderate estimate, and that a crow receiving only two such meals a day would soon become very attenuated.) He figured that the crows in that district were destroying daily a total of 25,000,000 grasshoppers, and as this crow invasion lasted for a month he put the total number of grasshoppers destroyed in the district at 750,000,000. This number reduced to tons would give a total weight of 100 tons of grasshoppers. But he said that even this figure failed to give a clear idea of the good work done by these crows. By careful computation he arrived at the conclusion that these 750,000,000 grasshoppers if not killed by the crows would have consumed over 2,000 tons of grass and other fodder. He thus came to the conclusion that through this destruction of grasshoppers the crows saved thousands of tons of grass and other products to the inhabitants of the Mossvale district. He says, also, that a significant feature of the locust plague in 1891 in the western part of New South Wales was the

TABLETS TO THE SEA GULLS.

On the monument erected by the grateful people of Salt Lake City to commemorate the advent of the gulls that by destroying the crickets saved the first settlers from starvation. (From Bird-Lore.)

presence of large flocks of these black police in parts of the infested districts.[1]

The Australian correspondence of the Mark Lane Express of March 7, 1892, speaks of the value to the farmers of ibises and other birds during the locust invasions of that year in the Glen Thompson district near Ballarat, Victoria. A swarm of locusts was noted in a paddock, and when it was feared that all the sheep would have to be sold for lack of grass, flocks of starlings, spoonbills and cranes appeared and destroyed the locusts so completely that only about 40 acres of grassland were ravaged.[2]

Similar services were performed by birds in the western United States during the great locust visitations that followed the settlement of the States in the Mississippi valley. When these tremendous irruptions of locusts appeared, practically all birds, from the tiny kinglet to the great whooping crane, fed upon them. Professor Samuel Aughey, who investigated the food of these locust-eating birds, noted many localities where the crops (or a part, at least) were saved by the work of flocks of birds which gathered there to feed on the locusts. Birds were effective even where, as in one case, the locusts had hatched to the number of 300 to the square foot. In 1869, in one instance, more than 90 per cent of the insects were destroyed by birds. At Fremont, Nebraska, S. E. Goodman found that the locusts came up "much thicker" than the wheat, but he said that the birds reduced them so that he got two-thirds of a crop, and he asserted that other farmers had a similar experience. In some cases the sprouting wheat was eaten clean to the ground, but flocks of blackbirds came, destroyed the locusts, and the wheat sprang up again and made a good crop. Page after page of the first report of the United States Entomological Commission was devoted to testimony of this kind.

The commissioners themselves say that "the ocular demonstration of the usefulness of birds was so full and complete during the past year that it was impossible to entertain any longer a doubt upon this point."[3]

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[1] Cobb, N. A.: The Common Crow, Miscellaneous Publication No. 103, Department of Agriculture, New South Wales, 1896, pp. 10–12.

[2] Insect Life, Vol. IV, 1891–92, p. 409.

[3] Riley, Packard and Thomas: First Report, United States Entomological Commission, 1877, pp. 335–342.

In 1919 the State of Washington, with the aid of agents of the United States Department of Agriculture, attempted the control of the coulee cricket which had devastated large areas in the vicinity of Adrian, Washington. According to Mr. Max Reeher, scientific assistant in the Bureau of Entomology, United States Department of Agriculture, western meadowlarks appeared in great numbers in the dry coulee in autumn, and began eating the newly hatched crickets. These birds were so effective in controlling the pest that all arrangements for a 1919 control campaign were abandoned. It is said that "the meadowlarks were almost entirely responsible for the complete clean-up of the area." [1]

The "seventeen-year locust," so-called (*Tibicina septendecem*), is not a locust, but belongs to the order Homoptera, containing cicadas, plant lice and scale insects. The destructive cicadas live most of their lives underground, where they feed on roots. They are attacked by many birds when they appear above the surface of the earth. Dr. J. B. Smith says that wherever the English sparrow has been introduced, the periodical cicada is doomed. He says that these birds seem to have an intense hatred for this insect, attacking it and pulling it to pieces in the most wanton manner, and near the large cities where these sparrows are numerous entire broods of the cicada have already disappeared. He asserts that in 1889 these insects appeared in Prospect Park, Brooklyn, New York, and in the surrounding woodland, but during a day's careful search he found only a single branch containing their eggs.[2]

Broods of this cicada that were due to appear in certain localities the past season (1920) failed to materialize; perhaps Dr. Smith's account explains why. Grackles also sometimes become very destructive to the periodical cicada. Mr. C. L. Marlatt, who was breeding these insects experimentally, says that under one tree a count and estimate was made of more than 5,000 openings from which the insects had emerged, and under other trees the openings ranged from a few hundred to 3,000. Notwithstanding the considerable numbers of cicadas which emerged, not one was seen on the trees during the days

[1] Burrill, A. C.: California Fish and Game, Vol. 6, No. 1, January, 1920, p. 38.
[2] Smith, J. B.: Economic Entomology, 1896, pp. 142, 143.

and weeks following. Each morning under these trees a considerable group of blackbirds could be seen which evidently had been feeding on the newly issued cicadas. Scarcely a single cicada escaped the sharp eyes of these birds. He says that the absolute failure of these insects to establish themselves when planted in such enormous numbers, even when the underground period had been successfully passed, owing to the relentless onslaught of birds, is a striking illustration of what is happening year after year with successive broods, especially in thinly forested regions, and accounts for their great reduction in number and the practical disappearance of local swarms formerly abundant.[1]

Birds sometimes clear plants and trees of insect pests before the presence of these pests has been brought to our notice. In November, 1905, on returning to Wareham after a long absence, I noted a flock of myrtle warblers and some goldfinches that were very busy among the apple trees, and were searching with particular diligence a pear tree near the house. I was told that they had been at that occupation for about two weeks. I realized at once that they must have been engaged upon those leafless trees in the suppression of some insect pest. A careful examination revealed the fact that the birds were working the trees thus carefully for little cicada-shaped insects, which were identified by Dr. L. O. Howard as the pear tree psylla (*Psylla pyri*), a European pest introduced into this country. These insects are extremely destructive to pear trees. Devastating invasions have occurred in Maryland, Virginia and New Jersey. These jumping plant lice are extremely prolific, having several broods each year. In the infested Maryland orchards the leaves and fruit fell, the latter before it was half grown. Enormous secretions of honeydew that the hosts of these insects produced from the sap of the trees fell like rain, drenching the horses used in cultivating the orchard, and running down the trunks in streams. On my farm, however, the birds which had been engaged for two weeks in clearing these insects from the pear trees had been so successful that it was difficult for me to find any of the insects on the trees, and in a few days I could not discover even a single specimen. But even after that the

[1] Proceedings, Entomological Society of Washington [District of Columbia], Vol. IX, 1907, p. 18.

birds looked over the trees occasionally and still found a few. By the end of another week they had exhausted the supply, and we never have been able to find a single specimen of these psyllas since. Dr. Howard intimates in a bulletin on this insect that the causes which control the increase and decrease in numbers are not fully understood. The birds constitute one agency of control that we can understand.[1]

Professor H. A. Surface reports that Mr. Mann, a well-known pear grower near Rochester, New York, told him that one year the pear tree psylla had destroyed his entire pear crop, amounting to thousands of dollars in value, and that in the autumn the eggs of the insects were so numerous that there seemed to be no prospect of a crop the following year, but during the winter white-breasted and red-breasted nuthatches worked in flocks in this orchard, with the result that in the spring Mr. Mann could hardly find an insect. Professor Surface asserts that these birds saved Mr. Mann thousands of dollars in that one winter.[2]

The red-breasted nuthatch; one of the species that saved a pear grower thousands of dollars in one winter by destroying eggs of the pear tree psylla.

One morning in the autumn of 1904 I saw in some poplar trees near the shore of the Musketaquid River, Concord, Massachusetts, a flock of myrtle warblers and black-poll warblers attacking a swarm of plant lice. The insects appeared in myriads; there were so many that it was impossible for me to estimate their numbers. They were mainly in the perfect form, and some of them were in flight. The birds pursued these through the air, but also sought those that remained on the trunks and branches. I watched the operations of these birds at intervals all day. Toward night some of the insects had scattered to neighboring trees, and a few of the birds were pursuing them there; but most of the latter remained all day about the place where the swarm was first seen. Hour after

[1] Useful Birds and their Protection, Massachusetts State Board of Agriculture, 1907, pp. 153, 154.

[2] Surface, H. A.: Zoölogical Quarterly Bulletin, Division of Zoölogy, Pennsylvania Department of Agriculture, Vol. 1, No. 3, November 15, 1903, p. 31.

hour the insects decreased rapidly, until just before sunset it was difficult to find any of them. But the birds remaining until nearly dark seemed still to find a few insects on the higher branches. The insects which I secured for identification were liberated or destroyed during the night, probably by white-footed mice which infested the camp. The next morning at sunrise I was unable, after a very careful search, to find a single plant louse on the trees. The birds, however, were still there. They disappeared one by one, but the last bird to linger was more successful than I, for it still found a few, but soon gave up the attempt and left for more fruitful fields. A few insects might have escaped by flight, but the next year I was unable to find a single specimen in the locality. This apparently complete destruction of these insects may have been due in some part to the cold of the winter of 1904–05, but the work of the birds was very thorough.[1]

In the year 1900 the introduced destructive pea louse (*Macrosiphum pisi*) was very prevalent, and was abundant on my farm at Wareham. We expected it to appear in the spring of 1901. The insect came as expected, but failed to increase as it had during the previous season. We found that chipping sparrows were eating them, and for two years these birds came wherever peas were planted and fed on the insects day after day so long as any could be found. A row of late peas 100 yards in length, an eighth of a mile from where the early peas were planted, became infested with these aphides in August, but the chipping sparrows soon found them and haunted the vines day after day until the insects became so reduced in numbers as to cause no further injury.[2] Probably this habit of the chippy was widespread, for Mr. H. W. Olds and Dr. Judd both have observed it.[3]

Every farmer knows that some of the greatest pests of the farm are found among the Coleoptera, or beetles. The leaf-eating beetles are among the most destructive, and of these perhaps the most notorious American species is the Colorado potato beetle (*Leptinotarsa decemlineata*). Every year the farmers of the United States spend an enormous sum for labor

[1] Useful Birds and their Protection, Massachusetts State Board of Agriculture, 1907, pp. 70–72.

[2] Massachusetts Department of Agriculture, Economic Ornithology Bulletin No. 4, 1920, pp. 28, 29.

[3] Bulletin No. 15, Division of Biological Survey, United States Department of Agriculture 1901, p. 77.

and insecticides to check this beetle, and every year, notwithstanding this great expense, it does considerable damage to the potato crop. Several kinds of birds destroy this insect, and a few species in particular are known to be very effective. Professor Beal gives a striking instance of the effect produced upon this pest by the rose-breasted grosbeak. A small potato field had been so badly infested with the beetles that the vines were completely riddled. Rose-breasted grosbeaks visited that field every day, and finally brought their fledged young to the topmost rail of the fence and fed them there with the beetles as they were gathered from the plants. On a careful inspection a few days later not a single beetle or larva could be found. The birds had cleared the field and saved the potatoes.[1] Many similar instances have been reported.

Early in the last decade Dr. Thomas E. Miller, then president of the State negro college at Orangeburg, South Carolina, told Mr. James Henry Rice, Jr., then chief game warden of that State, that he had no trouble with potato beetles. Investigation revealed the fact that bobwhites were abundant around his fields, where no shooting was allowed. His fields had been practically free from the beetles for years, while in the same county and in adjoining counties where birds were shot off it was necessary to make war on these beetles from the beginning to the end of the potato season. Four years later Mr. Rice himself planted potatoes in a field of 20 acres where for two years previously all shooting had been prohibited by a land company that had bought the tract. Mr. Rice allowed no shotgun to be carried on the place. Six coveys of bobwhites came into the field to feed. The potatoes were not sprayed, as it was impossible at the right time to get help to do the work. Paris green and lime were applied once, but the young man in charge was taken ill and the insecticide was washed off immediately by heavy rains. The beetles swarmed into the field. Mr. Rice watched them and saw the bobwhites eating both beetles and larvæ, and clearing the rows. The field was left to the birds and suffered no appreciable injury from the beetles. In 1915 I had a similar experience at my farm with a small patch of potatoes and a flock of bobwhites.

[1] United States Department of Agriculture, Farmers Bulletin No. 54, 1904, p. 29.

CRANBERRY PLANTS SAVED BY ROBINS.

The first setting was destroyed by white grubs, but robins dug out the grubs and the second setting was almost uninjured.

The imported elm-leaf beetle (*Galerucella luteola*) has destroyed many elms in New England. In recent years, however, it has not been so destructive as formerly. One reason for this may be found in the fact that cedar waxwings have become a notable enemy of the beetle. Mr. Outram Bangs gives an instance where, in Wareham, Massachusetts, these birds saved about 20 elm trees from destruction by these beetles. About the year 1904, when the trees were 15 to 20 feet in height, they were badly infested, but waxwings came regularly to the trees in constantly increasing numbers, searching every limb and twig. They often hung from the ends of the boughs, like chickadees, spying out the insects until they cleared them off. The trees were not afterwards troubled.[1]

Mr. J. M. Van Huyck informed me that in 1911 cedar waxwings appeared in flocks on the elm trees of Lee, Massachusetts, and in some cases absolutely cleared the trees of this pest.[2]

In 1915 Mr. J. M. Stone of Greenwich, Massachusetts, wrote that cedar waxwings had cut down the elm-leaf beetle to a considerable extent, and that he had seen them preying on the beetles by hundreds; that sometimes 20 or 30 birds alighted on a single limb, staying there five or ten minutes, and they were continually going through the trees taking the beetles from both limbs and leaves.[3]

Dr. S. D. Judd recorded the reduction by birds of an outbreak of locust-leaf miners at Marshall Hall, Maryland. He asserted that this beetle (*Odontota dorsalis*) became so abundant that it turned the green of the locust trees into an unsightly brown. Practically all the birds ate these beetles freely, and aided by their united attack in reducing the numbers of the insects to such an extent that they did not appear subsequently in sufficient force to repeat the damage.[4]

In the year 1914, on my farm at Wareham, a part of a newly set cranberry bog was attacked by white grubs of the May beetle and nearly every plant was killed. This grub

[1] First Annual Report of the State Ornithologist, Massachusetts State Board of Agriculture, 1908, p. 13.

[2] Fourth Annual Report of the State Ornithologist, Massachusetts State Board of Agriculture, 1911, p. 19.

[3] Eighth Annual Report of the State Ornithologist, Massachusetts State Board of Agriculture, 1915, p. 27.

[4] Bulletin No. 15, Division of Biological Survey, United States Department of Agriculture, 1901, p. 35.

remains in the soil destroying the roots of plants for several seasons, and usually is killed on cranberry bogs by flooding with water. In this case it was impracticable to flood the bog during the summer. In May, 1915, after new vines had been set, numbers of robins were seen at work upon the tract. They dug into the sand with their beaks and pulled out the grubs. In a very few cases the roots of the vines were cut off by the grubs, and these vines the robins pulled up and discarded, but dug out the insects. The birds worked so diligently that practically no grubs escaped. A few came to maturity and emerged from the sand as beetles and disappeared, but apparently the birds got all the rest. As a result the new vines nearly all survived. No other bird except the robin was seen to attack these grubs, although others may have done so.[1]

Butterflies and moths are not usually destructive; some of them do not feed at all in their perfect state, but the larvæ or caterpillars of most species feed on the foliage or other parts of trees or plants. Many of these larvæ may be ranked among the most destructive pests. The caterpillars and pupæ are eaten by many birds. Many caterpillars are armed with spines or stiff hairs, and these species are not usually eaten by birds in such numbers as are those that are not so protected. Nevertheless, many birds feed more or less on hairy caterpillars. Regarding this habit of the blue jay, Mr. J. B. Kirtland avers that in Cleveland, Ohio, he noticed one of these birds engaged in tearing open the web of the tent caterpillar (*Clisiocampa Americana*). This seemed so unusual that he was led to watch the proceedings of the jays, and in so doing found that before the young birds had passed from the care of the parents most of the caterpillar nests had been broken into, many were torn into shreds, and the number of occupants evidently diminished. Within two or three years not a caterpillar was to be seen in the neighborhood.[2] Wilson Flagg was one of the first to report similar habits of the Baltimore oriole.[3]

A correspondent from Rockville, Connecticut, contributes an item regarding the Baltimore oriole as an enemy of the tent

[1] Eighth Annual Report, State Ornithologist, Massachusetts State Board of Agriculture, 1915, pp. 26, 27.

[2] Atlantic Monthly, Vol. 25, 1870, pp. 483, 484.

[3] Annual Report, Massachusetts State Board of Agriculture, 1861 (1862), Abstract, p. 50.

WEB OF TENT-CATERPILLAR ATTACKED BY BIRDS.

The openings made by the beaks of birds can be seen plainly, also some dead caterpillars. (From Useful Birds and Their Protection.)

caterpillar. A friend noticed a large caterpillar's nest at the top of a tree in his apple orchard, and while wondering how it could be reached he saw that an oriole had flown into the tree and had gone at once to the nest which it soon tore open with its bill and then proceeded to devour the occupants. It flew away, but returned speedily with its mate, when the two contined to feast upon the caterpillars until apparently not a single one was left.[1]

For five years my own orchard was kept practically free of caterpillars by birds. In the spring of 1905 there were two nests which appeared to have escaped the attacks of birds, and one day I concluded to remove them, but was called to lunch and left the trees for half an hour. Upon my return the largest tent had been torn open and many dead caterpillars were scattered about mutilated in the manner characteristic of the Baltimore oriole. Several large holes in the web showed how they had been extracted. Many caterpillars were lying dead upon the ground. The tents were left to the tender mercy of the birds, and the occupants were destroyed by them.[2] Many people have observed this habit of the Baltimore oriole.

Mr. A. W. Butler, in speaking of the yellow-billed cuckoo, says that he has known it to destroy every tent caterpillar in a badly infested orchard, and tear up all the nests in half a day.[3]

Mr. Harry G. Higbee, superintendent of the Bird Sanctuary of the Massachusetts Audubon Society, at Sharon, Massachusetts, wrote on May 31, 1919, that many nests of tent caterpillars had been noted there early in the season. But he had watched cuckoos puncturing them and eating the caterpillars. Cuckoos had been so numerous there that the injury by this caterpillar had practically ceased.

Mr. Henry H. Seaver of Templeton, Massachusetts, asserts that a family of starlings which had built a nest in the wainscoting of a room in his house destroyed a small colony of the destructive introduced brown-tail moth (*Euproctis chrysorrhœa.*) The starlings found an entrance to the house through a waste-

[1] Cultivator and Country Gentleman, Vol. XLIV, 1879, p. 407.

[2] Useful Birds and their Protection, Massachusetts State Board of Agriculture, 1907, pp. 117, 118.

[3] Report, Indiana Department of Geology, Natural Resources of Indiana, 1897 (1898), p. 824.

pipe hole, built their nest and laid their eggs in the space between the outer boarding and the wainscoting. When the young were hatched it was noted that the parent birds were bringing caterpillars of the brown-tail moth and the gypsy moth to their young. There were no such caterpillars in the immediate vicinity of the house, so the birds were watched and were seen to bring them from an ancient apple tree in a pasture some distance away. They practically cleared this tree of these destructive insects before their food campaign for their family was over.[1]

Dr. Walter E. Collinge, the eminent British economic ornithologist, writing of the caterpillar of the currant or magpie moth, asserts that it requires about 170 of these to weigh an ounce. In their early stages about 200 will aggregate that weight. He says that he has seen currant plantations infested with them, and by counting the number to a bush has estimated nearly 1,000,000 to a plantation, or a total of 2½ hundredweight. Had such a horde been left undisturbed they would quickly have consumed all the foliage and ruined the crop, but thanks to the birds that attacked them they were reduced to innocuous numbers long before they had an opportunity of devastating the plantation.[2]

The forest tent caterpillar (*Malacosoma disstria*), a first-class forest pest, is eaten by many birds. Miss Mary B. Sherman of Ogdensburg, New York, wrote on May 18, 1900, that the town was then full of birds, and they were doing good work feeding on the forest tent caterpillar. She noted sparrows, warblers, cuckoos, robins and cedar waxwings attacking these larvæ. On May 26 she wrote that there were practically no caterpillars left. They hatched in large numbers, but cold weather evidently killed many, and the birds appeared to have destroyed the remainder.[3]

Even the very hairy tussock-moth caterpillar (*Hemerocampa leucostigma*) has a number of bird enemies. Dr. Sterling of Cleveland, Ohio, said that in the summer of 1880 the elms along Euclid Avenue in his vicinity were attacked by these caterpillars. Thousands were destroyed by the people in the

[1] Bulletin, Massachusetts Audubon Society, Vol. I, No. 9, January, 1918, p. 7.
[2] Agricultural Magazine, Vol. 10, No. 7, May, 1919, p. 126.
[3] Felt, E. P.: Sixteenth Annual Report, New York State Entomologist, 1901, p. 1019.

neighborhood, but when winter set in tens of thousands still remained on the outer branches beyond reach. About December 1 a pair of hairy woodpeckers came and fed daily on the pupæ. In the course of that month and the next, over a dozen more of the birds appeared, and their industry in regard to this particular pest attracted the attention of passersby. When March came round not a cocoon was to be seen in places where the branches had been literally white with them, — and this was the last that was seen of the pest.[1]

Mr. A. W. Anthony asserts that in southern California the passion vine is infested by a red butterfly (*Agraulis vanillæ*), the larvæ of which feed extensively upon this plant. The plants are often completely defoliated, and become so unsightly that in some regions many people have destroyed their vines and replaced them with others less liable to breed a horde of pests. Mr. Anthony says that he called on a friend living in the suburbs of San Diego, who had a large number of unusually thrifty passion vines climbing over his fence. Upon inquiring the reason of their freedom from the inevitable pest he was informed that a pair of road runners had paid daily visits to these vines for several months, climbing through them in all directions until they had captured the last caterpillar.[2]

The destruction of hairy caterpillars by birds is considerable, but instances where they have killed out hairless caterpillars probably are much more numerous. The late E. W. Wood of Newton, Massachusetts, formerly a well-known member of the Massachusetts State Board of Agriculture, informed me that during a season when spring cankerworms (*Anisopteryx vernata*) became quite numerous in his orchard, a pair of Baltimore orioles fed daily on the worms, meantime building a nest near by. When the young were hatched the parents redoubled their diligence, sometimes carrying ten or more worms to their nest at one time. Soon the cankerworms in that orchard had disappeared. The foliage and fruit were saved for that year, and for several succeeding years no noticeable damage was done.[3]

Cedar waxwings are very destructive to canker worms, and,

[1] Sterling, E.: Insect Life, Vol. III, 1891, p. 295.
[2] Auk, Vol. XIV, 1897, p. 217.
[3] Massachusetts State Board of Agriculture, Crop Report, Bulletin V, 1894, p. 30.

in fact, most birds feed on them. Several years ago I noted a serious infestation of this pest in an orchard in Westborough, Massachusetts, that finally was nearly cleared up by birds, prominent among which were flocks of cedar waxwings which spent a great part of the daylight hours feeding on these caterpillars.

Other hairless caterpillars taken by birds are cabbage worms and climbing cutworms. The chipping sparrow and the song sparrow have been noted frequently as enemies of the cabbage worm (*Pontia rapæ*). Dr. S. Schneck says that he was observing the cabbage patch early in the morning, from daybreak to a short time after sunrise, when he chanced to see a number of chipping sparrows taking cabbage worms. By continuing his observations he found that they kept up this practice every morning so long as the worms lasted.[1] In 1901 I had a similar experience with both chipping sparrows and song sparrows.[2]

Mr. J. B. Dunn of Corpus Christi, Texas, reports a bird enemy of the cabbage looper (*Autographa brassicæ*). He is quoted by Dr. F. H. Chittenden of the Bureau of Entomology to the effect that "a bird known locally as jackdaw (*Megaquiscalus major*) [probably the great-tailed grackle] was particularly fond of these cabbage loopers." These birds alighted in the fields and fed on the larvæ daily until they cleaned them up and saved the crop.[3]

Mr. J. L. Harris reports that another cabbage pest, the diamond-back moth (*Plutella maculipennis*) was extirpated from his patch by a flock of blackbirds.[4]

The larva of the snow-white linden moth (*Ennomos subsignarius*) no doubt is eaten by many native birds, but perhaps, owing to a scarcity of native birds in the seventh decade of the last century, it became a great pest in many cities of the eastern United States. This worm seems to be the special prey of the English sparrow. A. R. Grote, the well-known entomologist, wrote in 1883, "Many will recollect that the maple and other shade trees in Brooklyn and New York used to be completely defoliated by the middle of summer by the

[1] American Naturalist, Vol. XIV, February, 1880, p. 130.

[2] Economic Ornithology, Bulletin No. 4, Massachusetts Department of Agriculture, 1920, pp. 29, 30.

[3] Bulletin No. 33, Division of Entomology, United States Department of Agriculture, 1902, p. 68.

[4] Transactions, Minnesota State Horticultural Society, January, 1878, p. 63.

common brown drop or measuring worm. . . . The English sparrow rid us of this nuisance; it ate every one of them." [1]

Dr. John B. Smith, entomologist of the New Jersey Experiment Station, wrote as follows regarding this habit of the house sparrow: —

> On the evening of July 17 (1908), Newark, Elizabeth, Paterson, Jersey City and some of the surrounding towns were treated to a unique experience — a veritable swarm of snow-white moths flying around the electric lights and giving the appearance of a snowstorm in midsummer. . . . On the morning after the flight the sparrows apparently became very busy soon after daylight, and all that was left to mark it was numerous quantities of wings without bodies. . . . This flight was composed of individuals of the snow-white Eugonia, known everywhere half a century ago as the parent of the " span worm ". It was at that time the most abundant and destructive shade-tree insect in the eastern United States, and its caterpillars, feeding upon most of the shade trees, were a nuisance by their habit of suspending themselves by threads from the foliage upon which they fed, and dropping upon pedestrians moving beneath.[2]

The sparrows were introduced into this country to protect street trees and park trees from these caterpillars. They did their work well. It was not long before the caterpillars practically disappeared from the cities. Unfortunately, however, the sparrows, by driving out the native birds, brought about an increase of tussock moths, which for several years ravaged many street and park trees.

The pupæ of the codling moth are eaten by many birds. These moths spin cocoons beneath scales of bark on the trunks and large limbs of apple trees, where they are attacked, particularly during winter, by woodpeckers and titmouses. Mr. A. P. Martin of Petaluma, California, believed that there the destruction of this apple-tree pest was attributable to the red-shafted flicker. He said that in examining the crevices of the bark for codling moths in the spring he failed to find any, where there had been thousands in the fall. Upon investigation he found numbers of cocoons, but in every case the occupant of the cocoon was absent. In the scales of bark over each cocoon he found small holes where the pupæ had been drawn out. He noticed large numbers of flickers in the orchards during the early spring months industriously examining the trunks and

[1] Canadian Entomologist, Vol. XV, 1883, p. 235.

[2] Report, New Jersey Agricultural Experiment Station, 1908, pp. 317, 318.

large limbs of the fruit trees, and suspected at the time that they were in search of apple worms. He noticed, also, that these birds were busy around the sheds where he had stored his winter apples and pears, and that they got every worm that they could reach, even pecking holes deeply in the wood where there were cocoons in nail holes or crevices in the boards. As a result of several hours' search (at various times), before the time for the moths to emerge, he found only one worm, and that one had barely escaped, for others had been taken out within a quarter of an inch of its hiding place.[1]

In some localities the downy woodpecker is very destructive to the larvæ of the codling moth. Dr. Rufus H. Pettit, entomologist to the Michigan Experiment Station, records that in almost every case where cocoons of this insect were concealed under flakes of bark the birds had found them.[2] It is interesting to note, also, that several observers have seen this woodpecker extract the young apple worms from the calyx end of the fruit without any appreciable injury to the apple.

The following is a translation from Bernard Altum, showing how in Europe birds save trees by destroying eggs of the gypsy moth.

> In the year 1848 endless numbers of the larvæ of *Bombyx dispar* had eaten every leaf from the trees of Count Wodzicki, so that they were perfectly bare. In the fall all the branches and limbs were covered with the egg clusters. After he had recognized the impracticability of it, he gave up all endeavor to remove them by hand, and prepared to see his beautiful trees die. Towards winter numerous flocks of titmice and wrens came daily to the trees. The egg clusters disappeared. In the spring twenty pairs of titmice nested in the garden, and the larva plague was noticeably reduced. In the year 1850 the small feathered garden police had cleaned his trees, so that he saw them during the entire summer in their most beautiful verdure.[3]

The wrens referred to here probably were kinglets (*Regulus cristatus*), formerly known as golden-crested wrens.

American birds apparently have not yet learned to destroy great quantities of the eggs of the gypsy moth, although several species are said to eat them; but nearly 50 species are now

[1] Pacific Rural Press, Vol. XXXIX, No. 23, June 7, 1890, p. 580.
[2] Bulletin No. 222, Michigan Experiment Station, December, 1904, p. 89.
[3] Forstzoölogie, Vol. II, 1880, p. 324.

known to destroy other forms of this moth, and I have examined two localities where birds are believed to have actually extirpated small colonies of this insect.

Decrease of Birds followed by Increase of Destructive Insects.

Samuels tells us that Frederick the Great, fond of cherries, ordered the destruction of sparrows which were stealing his favorite fruit. A price was set on their heads throughout Prussia, and the war against them was carried on successfully. At the end of two years there were no sparrows, but neither were there any cherries; and most other fruits also were wanting. The trees swarmed with caterpillars, lacked leaves, and so produced little fruit. Insects had increased to an alarming extent, since other birds had been killed or driven away by the drastic measures employed against the sparrows. Finally the King revoked his decree, but also felt obliged at considerable expense to import birds to take the place of those destroyed.[1]

In 1798 the forests in Saxony and Brandenburg were extensively attacked by a lepidopterous insect that bored into the wood and killed the trees. This became so general a calamity that expert foresters and naturalists were sent by the regency to inquire into the cause. From their report it became apparent that the extraordinary increase of this insect and the consequent destruction of the trees was due to the absence for years of several species of woodpecker and titmouse.[2]

Réaumur asserts that in 1826 the great trees along that noble avenue, the Alle Verte, at Brussels, were nearly deprived of leaves by the caterpillars of the gypsy moth. In the autumn the moths swarmed like bees; they were very abundant in the park, and if one-half their eggs had hatched there would not have been a leaf left in 1827. Two months later, however, hardly an egg could be found. The extirpation of these eggs was attributed to titmouses, creepers and other small birds which abounded in the park and were known to eat the eggs of these insects.[3]

[1] Annual Report, Massachusetts State Board of Agriculture, 1865 (1866), pp. 116, 117.

[2] Flagg, Wilson: The Utility of Birds, Annual Report, Massachusetts State Board of Agriculture, 1861 (1862), Abstract, pp. 66, 67.

[3] Kirby, William, and Spence, William: Entomology, 1846, p. 152.

Birds seem to have been numerous and unmolested at that time in Brussels parks, but years later, under a policy of bird destruction, insects got the upper hand.

In 1858 Kearly wrote that sparrows and other birds had appeared at the park in Brussels in unusual numbers. This should have warned the authorities that insect pests were becoming numerous there, but, instead, the birds were declared a nuisance, their destruction was ordered, and the order was carried out. The next year insects swarmed in the park. The gypsy moth stripped nearly all the trees of their foliage, and the last condition was worse than the first.[1]

After the French Revolution, when the game laws were abolished, people, being accustomed to regard birds as the property of the great landowners, began to destroy birds and game without limit. This slaughter was followed from time to time by an increase of pernicious insect pests, and resulted in great distress through crop failure. Investigation by naturalists proved that the destruction of birds was the indirect cause of the failure of the crops.[2]

In 1861 the French harvests gave such an unusually poor return that a commission to inquire into the cause of the deficiency was appointed at the instance of the Minister of Agriculture. The commission consulted expert naturalists, St. Hilaire, Provost and others, and reported that the crop deficiency was caused in great measure by the ravages of insects which it is the function of certain birds to check. It was shown that the people had been destroying such birds and collecting their eggs in great numbers, and it was recommended that prompt and energetic measures should be taken to stop the killing of birds.[3]

Similar complaints were heard again from France within the last decade. In 1910, according to André Godart's volume, "Les Jardins Volieres," the scarcity of birds (due to insufficient protection) was so great as to have been deemed responsible for the loss of 40,000,000 francs to the grape growers of the Gironde. Unchecked insect ravages had so decreased the olive crop of southern France that the discouraged growers talked of

[1] Kearly, George: The Entomologists' Weekly Intelligencer, 1858, Vol. 4, p. 192.
[2] Annual Report, Massachusetts State Board of Agriculture, 1861 (1862), Abstract, pp. 65, 66.
[3] Report, United States Commissioner of Patents (Agriculture), 1861, pp. 322, 323.

abandoning their industry. M. Godart in proposing a remedy even went so far as to advocate the construction of large aviaries in which birds could be reared under protection and released to repopulate the deserted woods and fields.[1]

In 1914 a bitter cry went up again from French farmers regarding crops destroyed by insects and lessened yields. The Société d'Horticulture Pratique du Rhone, by way of warning to the public, gave statistics of the enormous number of birds that had been destroyed by the people, and recommended strict law enforcement and education to stop bird destruction.[2]

The unusually severe weather of February, 1917, was very destructive to birds in England. They were reported to have died by thousands. Many birds also had been killed and the eggs of others taken and used for food. The next year birds were seen to be comparatively scarce. Then, apparently in consequence of the scarcity of birds, insects notably increased. According to the "London Times" of October 9, 1917, there was a plague of caterpillars in many districts that had almost stripped the trees of their leaves at the beginning of that summer.[3]

In 1895 I received a letter from Monsieur J. O. Clercy, then secretary of the Society of Natural Sciences, Ekaterinburg, Russian Siberia, in which he said that the ravages of cutworms and of ten species of locusts had contributed (together with the dryness of the season) to produce a famine in that region. He asserted that one of the evident causes which permitted such a numerous propagation of insect pests was the almost complete annihilation of birds, most of which had been killed and sent abroad by wagonloads for ladies' hats.[4] The cause of the infliction was so evident that a law for the protection of birds was enacted, thus "locking the stable door after the horse had been stolen."

Professor Samuel Aughey of Nebraska gathered statistics in regard to the killing of bobwhites and prairie chickens for the market between 1864 and 1877, and also made a study of the

[1] Oldys, Henry: Current Items of Interest, Audubon Society of the District of Columbia, No. 33, June 23, 1917.

[2] Sainsbury, Edwin F.: Our Dumb Animals, June, 1914, p. 10.

[3] Oldys, Henry: Current Items of Interest, Audubon Society of the District of Columbia, No. 37, June 29, 1918.

[4] Forbush, E. H., and Fernald, C. H.: The Gypsy Moth, Massachusetts State Board of Agriculture, 1896, pp. 205, 206.

poisoning of other birds which were destroyed in great numbers because they attacked the crops. The poisoning of these birds, he believed, permitted a great increase of destructive insects, particularly locusts. A farmer from Wisconsin informed me that after the blackbirds in his vicinity had been killed off by poison, white grubs increased in number and destroyed the grass roots so that he personally lost $400 in one year from this cause.

About twelve years ago Mr. Gardiner Hammond, who then owned a large sheep farm on the Island of Martha's Vineyard, informed me that the crows were killing his young lambs, and that he had instituted a campaign against crows by offering 50 cents each for their heads. He said that this campaign had been so successful that the payment of the bounty almost bankrupted him at the time. The crows had nearly all disappeared from his immediate vicinity. A few years later he inquired if I could tell him what was the matter with the grass in his pastures. The roots had been cut off and the upper part of the turf had been separated from the lower part. The grass in great patches was dead and could be rolled up from the turf like a carpet. I reminded him that I had advised against the crow campaign, and he was now seeing the result of shooting too many crows. In all probability, only a few crows had been killing his lambs, and if he had set a hunter to watch and shoot the actual culprits he would have saved his lambs and also his pastures. The cause of the destruction of the grass was an extreme multiplication of the larvæ of the May beetle which cut off the roots. Crows are very destructive to these beetles, and when their repressive force was removed, the beetles multiplied exceedingly and destroyed the grass roots.

A similar but much more impressive account of the devastation of grasslands by grubs following the almost complete destruction of birds comes from Australia.

Mr. C. W. Beebe, curator of birds at the New York Zoölogical Park, received a letter from Sydney, New South Wales, dated September 12, 1908, in which the writer, Mr. Richard Walter Tomalin, says: —

In the sub-districts of Robertson and Kangaloon, in the Illawarra district of New South Wales, what ten years ago was a waving mass of Eng-

lish cocksfoot and ryegrass, which had been put in gradually as the dense vine scrub was felled and burnt off, is now a barren desert, and nine families out of every ten which were renting properties have been compelled to leave the district and take up other lands. This is through the grubs having eaten the grass out by the roots. Plowing proved to be useless, as the grubs ate out the grass just the same. While there recently I was informed that it took three years from the time the grubs were first seen until to-day to accomplish this complete devastation; in other words, three years ago the grubs began work in that beautiful country of green mountains and running streams.

The birds had all been ruthlessly shot and destroyed in that district, and I was amazed at the absence of bird life. The two sub-districts I have mentioned have an area of about 30 square miles, and form a tableland about 1200 feet above sea level.[1]

In the summer of 1914 a severe outbreak of the army worm (*Leucania unipuncta*) occurred in southeastern Massachusetts. On August 1, accompanied by Mr. Walt McMahon, I went to Martha's Vineyard and visited a farm at North Tisbury. Army worms were present there in enormous numbers. Their season appeared to be about over and their destructiveness seemed to have just passed its height. On fields where the corn had stood more than waist high the crop had been eaten down to the ground, leaving no visible evidence that corn had grown there. In other fields there still was a little corn left standing. Nearly all the turf in the grass fields appeared dead and brown. Here trenches had been plowed about the fields to protect them. Large quantities of poisoned bran had been scattered and had destroyed some of the worms, as we saw the remains of it and many dead caterpillars. It was reported that these caterpillars had lain over a foot deep in some of the trenches, but these had been plowed under. Here we saw almost no birds; the only small bird noted was one red-winged blackbird. A farmer on the ground stated his belief that the poisoned bran had killed the birds, or that they had been killed by eating poisoned army worms. It was said that some turkeys also had been poisoned on another farm.

[1] Oldys, Henry: Current Items of Interest, Audubon Society of the District of Columbia. No. 3, April 15, 1909.

Increase of Birds followed by Decrease of Destructive Insects.

As an extreme contrast to the condition of the farm mentioned above, let me present another experience. Later in the day we went to the State bird reservation on the island. Here the army worms appeared to have been nearly as numerous as at the other place, but no poison had been used because of the danger of poisoning the heath hen, a bird now nearly extinct, for the preservation of which this reservation was established. The condition of the fields here was much better than at North Tisbury. There was no noticeable injury in the cornfields. The grass had been eaten somewhat in some of the fields, but apparently there was no serious damage. Particular efforts had been made here for years to attract and protect birds, and these efforts had been successful. Many nesting boxes had been put up on fences, posts, poles, etc., and most of them were occupied. Birds were seen everywhere. Bushes at the borders of the fields were more or less whitened by their excrement, which showed that they had been living on animal food. With our glasses many birds could be seen feeding on the army worms. Many heath hens were noted in the fields, apparently picking up these insects. Among the birds seen to feed on these worms were the chipping sparrow, English sparrow, field sparrow, song sparrow, robin, flicker, bluebird and red-winged blackbird. Apparently, also, the brown thrasher, towhee and kingbird were eating them, and people reported that cowbirds, catbirds, yellow-legs and upland plovers also had attacked them. Robins appeared to be among the most effective of all, and English sparrows were quite numerous in the fields. The difference between the result of the insect invasion at North Tisbury and that at the heath hen reservation seemed to have been attributable mainly to the scarcity of birds at the former locality and their abundance at the latter.

On my own place at Wareham, in this particular year, much pains had been taken to attract birds, and on neighboring farms to the eastward nesting boxes had been put up so that altogether more than 75 had been erected. Most of these were occupied by birds early in the season. Here, again, we had ocular evidence of the utility of birds. While photo-

DESTRUCTION BY THE ARMY WORMS.

Cornfield on Marthas Vineyard where a quantity of poisoned bran was used and birds disappeared.

BIRDS SAVED THIS CORNFIELD FROM THE ARMY WORMS.

Here no poisoned bran was used, but birds had been attracted, were present in large numbers, and destroyed the caterpillars.

graphing birds we noted that they were bringing army worms to their young, and neither my crops nor my neighbor's, on whose premises these nesting boxes had been put up, suffered at all by the army worms. Twenty rods west of my farm some injury was done to the grass by the worms, and from there over and through the town of Wareham, where no attempt had been made to increase the birds, much grass was eaten and some corn. Where birds are sufficiently abundant, they destroy the first generation of the army worm, and so prevent excessive increase. Usually, when the first brood is unchecked, it is the second generation of the year that becomes numerous enough to devastate the crops.[1]

In 1894 my assistant, Mr. Charles E. Bailey, experimented in an old orchard on my ground at Medford, Massachusetts, to determine whether any effect on orchard pests could be produced by attracting birds. The trees were not sprayed nor protected from insects in any way, but food was provided for birds in winter, nesting boxes were erected in spring, and an attempt was made to protect birds from their enemies. By these means the number of birds feeding about the place was much increased. It happened that orchard insects were very plentiful and destructive that year, but the birds in our orchard destroyed many thousands of eggs and females of the fall and spring cankerworm moths, eggs of the tent moth, caterpillars of the gypsy moth, case-bearers, tineids, etc. By examining the contents of the stomachs of chickadees, Mr. Bailey reached the conclusion that a single chickadee in twenty-five days would destroy 138,750 eggs of the cankerworm moth. The significant outcome of our experiment was, that while all the other orchards in the neighborhood except the one nearest ours were stripped of their

Black-capped chickadee, a destroyer of orchard and forest pests.

[1] Seventh Annual Report of the State Ornithologist, Massachusetts State Board of Agriculture, 1914, pp. 20–22.

foliage and bore no fruit that year, our orchard remained in full foliage and produced a full crop of fruit.[1]

Mr. B. A. Arnold who, in the summer of 1913, lived at Northeast Harbor, Maine, wrote me that a spruce moth (probably one of the Tortricids) had become quite abundant in that vicinity, so much so that people were beginning to fear the destruction of the spruce woods. He had noticed that the red squirrels which were numerous in the woods were protecting the moths by destroying the eggs and young of warblers and other small birds; therefore he had killed off the squirrels on the peninsula on which his cottage was situated and which was connected to the mainland only by a narrow neck of land. Many young warblers were reared on his place, and the birds

Egg clusters of the cankerworm moth, eaten by chickadees.

could be seen at all hours of the day hunting their food on the spruces. In a short time the trees were cleared of both worms and moths and the pest was stayed, while on the mainland the defoliation of the trees still continued.[2]

In 1916 and 1917 the groves in the parks at Minot, North Dakota, were attacked by thousands of measuring worms. In 1918 Mr. Will O. Doolittle took measures to attract wild birds, which came in numbers and soon freed the trees of the pests. Chickadees, nuthatches and woodpeckers, attracted to the parks, became very tame by constant feeding and attention, and cedar waxwings, rose-breasted grosbeaks and kingbirds showed particular efficiency in ridding the trees of their insect enemies.[3]

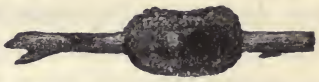
The late Rev. William R. Lord reported on December 1, 1913, that the town authorities of Dover, Massachusetts, had been cutting down wild cherry trees because those trees harbored

[1] Annual Report, Massachusetts State Board of Agriculture, 1895 (1896), pp. 347–362.

[2] Sixth Annual Report of the State Ornithologist, Massachusetts State Board of Agriculture, 1913, p. 27.

[3] Oldys, Henry: Current Items of Interest, Audubon Society of the District of Columbia, No. 38, July 1, 1918.

tent caterpillars. Mr. Lord refused permission to have the trees on his estate cut, as he had been attracting birds about the place and desired to raise wild cherries as food for them. The caterpillars did very little harm on his estate. In the fall of 1913 many tent caterpillar moths had laid their eggs on his trees, but in late November when he examined the trees he found that the birds, mainly chickadees, had removed nearly all the egg clusters.



Eggs of the tent caterpillar moth, an enemy of the apple tree, eaten by chickadees and blue jays.

Baron Hans von Berlepsch experimented for many years with methods for attracting birds at his estate in Thuringia by means of nesting boxes, food plants and bird food. He thus increased enormously the number of birds on his estate. The practical value derived from the insect-eating habits of his birds was shown in the spring of 1905.

The Hainich wood, south of Eisenach, which covers several square miles, was entirely defoliated by the caterpillars of a little moth (*Tortrix viridana*), but the woods on the near-by estate of Baron Von Berlepsch were left entirely untouched by the caterpillars, so that they actually stood out from the surrounding barren leafless woods like a green oasis in the countryside. At a distance of a little more than a quarter of a mile from his estate the first traces of the plague were apparent, and half a mile away it was in full force. This plainly showed how far the birds from his estate had traveled to find food.[1]

Similar observations were made during a plague of the same caterpillar in 1906 in the Crown Wood Harras, in the Grand Duchy of Hesse, where the protection of birds had been carried on energetically for a few years; also the abundant use of nesting boxes in the Prussian woods at this same period brought about a marked decrease in at least two species of destructive insects.

Birds as Weed Destroyers.

Fighting weeds occupies about 30 per cent of all the time a farmer spends in cultivating his crops, according to experts of the United States Department of Agriculture. Birds assist the

[1] Hiesemann, M.: How to Attract and Protect Wild Birds, London, 1912, pp. 50, 51; translation by Emma S. Buchheim.

farmer by destroying weeds. Sparrows, doves, bobwhites and many other birds feed voraciously on the seeds of weeds during autumn and winter. Sparrows are pre-eminently seed eaters, and destroy vast quantities of weed seeds. Dr. Judd made a thorough study of the subject. He found that a single weed sometimes produced many thousands of seeds, but he also estimated that the birds on one acre of a Maryland farm ate 46,000 weed seeds for their breakfast. Professor F. E. L. Beal estimated that the tree sparrows of Iowa destroy about 875 tons of weed seed annually during their winter sojourn.[1] Instances have been known where sparrows have eaten practically all the weed seeds in certain small tracts, but these are rare. Undoubtedly the destruction of weed seeds by birds in grass fields or grain fields is a benefit. In gardens or on truck farms weeds are a blessing in disguise, as they stimulate hoeing and cultivation, and thus bring about a surface tilth which often is essential to the conservation of moisture. Therefore the utility of weed-eating birds in the garden is questionable.

Birds as Distributors and Planters of Seeds.

Recent investigations have shown that in some cases a few weed seeds pass through the alimentary system of some birds uninjured. In such cases the bird may become a distributor and planter of weeds in a small way, and may thereby offset the good done by eating seeds, but in nature seed distribution is necessary to keep the soil covered with vegetation and prevent erosion.

Waterfowl and wading birds sometimes carry seeds of water plants from place to place in bits of mud attached to their feet. Jays, crows, magpies and some other species seem to have a mania for distributing and hiding things. No doubt many seeds, especially chestnuts and acorns, are hidden away by birds and never found by them again. Sudden fright often causes a bird to drop food that it is carrying. All fruit-eating birds scatter abroad the seeds of fruit on which they feed. Such seeds are either passed uninjured through the alimentary canal, or are ejected from the mouth after the pulp has been digested. Birds assimilate fruit pulp very rapidly. Dr. E. A. Mearns

[1] Judd, S. D.: Bulletin No. 15, Division of Biological Survey, United States Department of Agriculture, 1901, p. 27.

found that more than 900 juniper berries passed through the digestive tract of a Bohemian waxwing in six hours. Mr. Frank J. Phillips gives a list of 26 birds that eat juniper berries.[1] Probably others also eat them and assist in distributing the seeds. The seeds and pits of the larger fruits eaten by birds are mostly regurgitated and they are scattered far and wide. Birds alone would soon replant all the cleared lands were it not for the mowing machine, the reaper and the tools of cultivation. The tangles of trees, shrubs and vines that so often spring up along the fences and roadsides are due largely to planting by birds.

Birds as Scavengers.

Birds perform a valuable service as scavengers. The utility of vultures, ravens and crows, in quickly devouring garbage and the decaying carcasses of animals, is well known, and this service is particularly valuable in hot countries. Gulls and some other sea birds are particularly useful in cleaning up the garbage of large cities when it is dumped into the sea. Everything edible that floats is destroyed by the gathering thousands of these birds, and is thus prevented from drifting back upon the beaches. Masses of dead and decaying fish or shellfish thrown upon the shore by the waves are quickly disposed of by gulls. Complaints have been made that they have even stolen dead fish used to manure the fields. Only recently on Long Island it is said that a farmer bought and paid for tons of starfish that he intended to use as fertilizer, but when he came with his teams to haul them away the heap had disappeared. Eyewitnesses said that the gulls had stolen them all. This story illustrates how quickly the assembling gulls remove a malodorous nuisance, and how vigilant they are in this service.

Utility of Birds of Prey.

Birds of prey perform a part in the economy of nature by limiting the increase of many of the larger insects, besides some of the smaller birds and mammals, which if unchecked might cause great disturbances in the balance of Nature. These raptorial species are checks upon the increase of other natural

[1] The Dissemination of Junipers by Birds, reprint from Forestry Quarterly, Vol. VIII, No. 1, pp. 5, 15, 16.

enemies of birds. They are active, also, in limiting to harmless bounds the many creatures on which they prey.

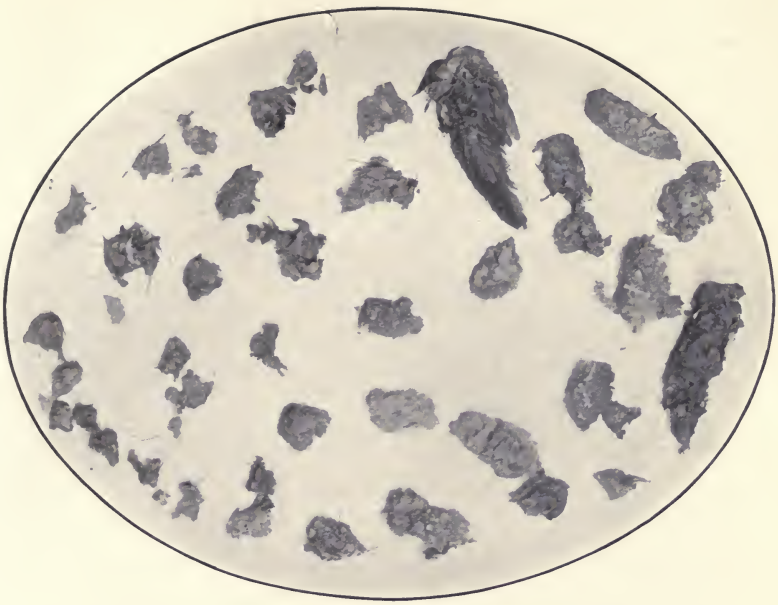
Owls destroy great numbers of nocturnal creatures, such as rats, mice and the larger night-flying insects. Both hawks and owls render valuable service to the farmer by holding in check the increase of small mammals, such as squirrels, gophers, lemmings, wood mice and field mice. These little animals are not very destructive when in normal numbers, but field mice, for example, are very prolific, each pair producing a large number of young each year. They breed so rapidly that unless held in check they soon overrun the country, destroying grass, grain, trees and practically every green thing, also the eggs of game birds and other ground-breeding birds.

The majority of the hawks and owls spend most of their feeding hours in hunting for and destroying such small mammals, and their capacity for such food is enormous. Lord Lilford reports that he has seen a pair of barn owls bring food to their young seventeen times within half an hour, and that he fed nine mice in quick succession to a young barn owl two-thirds grown.[1] As the owls throw up the indigestible parts of their food, pellets composed mainly of fur and bones may be found in the vicinity of their nests or roosts. In 1890 a pair of barn owls occupied a space in the upper part of a tower in the Smithsonian Institution at Washington, District of Columbia. An examination of 200 of the pellets found there gave a total of 454 skulls. There were remains of 225 field mice, 2 pine mice, 179 house mice, 20 rats, 6 jumping mice, 20 shrews, 1 mole and 1 vesper sparrow.[2] Mr. O. E. Niles asserts that he found 113 dead rats on the ground below a great horned owl's nest, and several more in the nest. Their skulls had been opened and their brains removed.[2]

The young of hawks and owls remain a long time in the nest and require a great quantity of food. Dr. A. K. Fisher of the Biological Survey examined the stomach contents of 690 hawks and owls from various parts of the United States, and concluded, as a result of these examinations and correspondence with many observers, that most hawks are more or less beneficial to agriculture, and most owls are exceedingly useful birds.

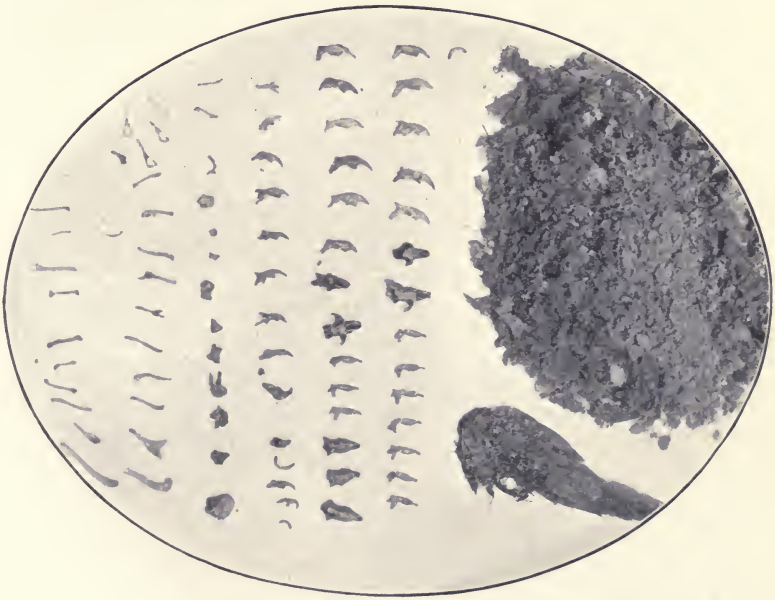
[1] Tegetmeier, W. B.: The Field [London], Vol. LXXV, No. 1956, June 21, 1890, p. 906.

[2] Fisher, A. K.: Hawks and Owls of the United States, Bulletin No. 3, Division of Ornithology and Mammalogy, United States Department of Agriculture, 1893, pp. 136, 176.



REGURGITATED OWL PELLETS.

These pellets, composed of bones and fur, also feathers of a robin, were ejected near author's house by screech owls. (From Useful Birds and Their Protection.)



THE SAME PELLETS DISSECTED.

The fur is shown in a pile on the right, and on the left portions of skulls and other bones of mice, with a few of shrews and moles, eaten by the owls. (From Useful Birds and Their Protection.)

In many parts of the world irruptions of lemmings, gophers or field mice have occurred, and in such cases rapacious birds have gathered, forming more or less effectual checks on these outbreaks. Such occurrences are on record in England and Scotland. The following quaint account, taken from Stowe's "Chronicle" in 1581, tells of an outbreak in England: —

About Hallowtide last past [1580] in the marshes of Danessey Hundred, in a place called South Minster, in the county of Essex, there sodainlie appeared an infinite number of mice, which overwhelming the whole earth in the said marshes, did sheare and gnaw the grass by the roots, spoyling and tainting the same with their venimous teeth in such sort that the cattell which grazed thereon were smitten with a murraine and died thereof; which vermine by policie of man could not be destroyed, till at the last it came to pass that there flocked together such a number of owles, as all the shire was able to yield, whereby the marsh-holders were shortly delivered from the vexation of the said mice. The like of this was also in Kent.[1]

Similar "sore plagues" were experienced in Essex again in 1648, in Norfolk in 1745, and in Gloucestershire and Hampshire in 1813–14.[2]

The following extract regards Norfolk: —

Once in about six or seven years, Hilgay, about one thousand acres, is infested with an incredible number of field mice, which, like locusts, would devour the corn of every kind. Invariably there follows a prodigious flight of Norway owls, and they tarry until the mice are entirely destroyed by them.[3]

Notwithstanding that both the cause and remedy of these frequent outbreaks of field mice were apparent, the destruction of their natural enemies by man still went on. In 1875–76 a noted outbreak of mice occurred in the borders of Roxburghshire, Selkirkshire and Dumfriesshire, also in parts of Yorkshire. The abundance of mice attracted hawks, owls and foxes in unusual numbers. In 1892 an alarming increase of these field mice again occurred in the south of Scotland. In Roxburgh and Dumfries alone the plague was estimated to have extended over an area of 80,000 to 90,000 acres.[4] A preponderance of opinion among the farmers was reported, tracing the cause of this outbreak to the scarcity of owls, hawks, weasels and other so-

[1] See also an account of the same occurrence by Childrey in Brittannia Baconica, 1660, p. 14.
[2] Journal, Royal Agricultural Society, 1892, p. 223, and papers there cited.
[3] Gentleman's Magazine, 1754, Vol. XXIV, p. 215.
[4] Report to the Board of Agriculture on the Plague of Field Mice or Voles in the South of Scotland, 1892.

called vermin. All these animals, and crows, also, are to be ranked among the natural enemies of mice. The statement made by Childrey regarding the assemblage of owls when the field mice swarmed in Essex in 1580 received confirmation during 1892. Local observers reported that, after the great increase of voles occurred, the short-eared owl (*Asio flammeus*) became much more numerous on the hill farms, and that many pairs, contrary to precedent, remained to breed.

Dr. W. B. Wall expresses the opinion, from his experience with the pests, that their chief enemies are the owl and the kestrel (a hawk), which do more to reduce their ranks than all the traps of the farmers and the "microbes of the scientists" combined. Both farmers and gamekeepers in England and Scotland are inclined to regard these birds as vermin, to be shot at sight.[1]

Any one who doubts that under normal conditions of Nature the natural enemies of field mice can check effectively any irruption of these creatures should read a chapter in one of Hudson's books, entitled "A Wave of Life." He writes of a time when the pampas of the La Plata were mainly a wilderness inhabited only by scattered bands of Indians. He says that in the summers of 1872 and 1873 (which would correspond chronologically with the winter of those years in North America), an unusually fertile and prolific season there, mice became so abundant that domestic fowls pursued them incessantly. Foxes, weasels, cats and even armadillos fared sumptuously. Storks and owls greatly increased in numbers. "On the pampas," he says, "whenever mice, frogs or crickets become excessively abundant we confidently look for the appearance of multitudes of the birds that prey on them." Years may have passed when hardly an individual of any of these birds was to be seen, but now the stork, short-eared owl, black-backed gull, hooded gull and other species appear, a few at first, like harbingers, and before long they arrive in myriads. Short-eared owls remained in numbers, and, supplied with abundant food, began to breed in winter. "As the mice increased," he says, "so did their enemies." Insectivorous and other species acquired the habits of owls and weasels, preying exclusively on mice, while to the

[1] Useful Birds and their Protection, 1913, pp. 76–78.

WHITE-FOOTED OR DEER MOUSE.
A destructive wood mouse, the increase of which is controlled largely by hawks and owls.

FIELD OR MEADOW MOUSE.
A prolific and devastating mouse, held in check by hawks and owls.

army of resident birds were shortly added multitudes of wandering ones from distant regions. In the autumn the earth so teemed with mice that one could scarcely walk without treading on them; but so rapidly were they devoured by the trained army of their enemies that in spring it was hard to find a single survivor, even in the barns and houses. The storks all left in winter, and by August, 1873, even the short-eared owls had vanished. Mice were now so scarce that the little resident burrowing owls were almost famished, and hung about the houses of the settlers to pick up scraps of garbage that were thrown to them.[1]

In many parts of the western United States the destruction of the natural enemies of rodents has now gone so far that these animals have increased greatly in numbers. Whole communities find themselves compelled to turn out to hunt "jack rabbits." The Biological Survey has been obliged to organize the farmers over large areas in the work of poisoning mice, gophers and ground squirrels. Bounties have been offered on the heads of these creatures, and large sums have been paid out for their destruction. In one case in Montana in 1887 a special session of the Legislature was called to repeal the bounty act and save the State from bankruptcy. In the Humboldt valley in Nevada, in 1907–08, the loss to crops by an irruption of field mice was estimated conservatively at $250,000.[2] It was estimated that 2,000 raptorial birds and 1,000 predatory mammals gathered and assisted to quell this outbreak, and that they destroyed 1,350,000 mice each month, yet there were not enough of these carnivorous creatures left in that country to check the pest materially, and the farmers were compelled to resort to poisons.[2]

In New England our common hares, miscalled rabbits, are kept in check by the hunter. But field mice, not subject to this check, destroyed thousands of young fruit trees during the winters of 1903–04 and 1904–05.

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[1] Hudson, W. H.: The Naturalist in La Plata, 1895, pp. 58–63.

[2] Piper, Stanley E.: Mouse Plagues and their Control and Prevention, Yearbook, United States Department of Agriculture, 1908, pp. 302, 304.

Services rendered by Shore Birds, Marsh Birds, Waterfowl and Sea Birds.

The usefulness of snipes, woodcocks, sandpipers, plovers, curlews and other shore birds and marsh birds as insect destroyers is not generally appreciated. Many species feed voraciously on marsh and field insects, such as cutworms, grass-

Killdeer plover, one of the most useful birds of the field.

hoppers, locusts, wireworms and grubs. In their spring migrations through the Mississippi valley region, shore birds destroy countless hordes of grass-eating and crop-destroying insects. Species that breed inland in agricultural regions, such as the killdeer, mountain plover, upland plover, spotted sandpiper and long-billed curlew, are so useful throughout the year that they should be protected by law perpetually for the benefit of agriculture. The killdeer and the upland plover also befriend cattle by devouring the North American fever tick.

Professor Aughey found that 23 species among the shore birds and 10 species of wild-fowl were actively destroying locusts and other insects in Nebraska, and Mr. W. L. McAtee finds that grasshoppers are a staple food of many shore birds.[1] Mr. H. W. Tinkham of Touisset, Massachusetts, watched six spotted sandpipers preying on cutworms and cabbage worms. The diet of shore birds includes such pests as army worms, cutworms, boll weevils, clover-root curculios, clover-leaf weevils, rice weevils,

[1] McAtee, W. L.: Bureau of Biological Survey, United States Department of Agriculture, Circular No. 79, 1911, p. 4.

corn billbugs, corn-leaf beetles, cucumber beetles, ticks, horse-flies and mosquitoes. Nine species are known to feed on mosquito larvæ, and doubtless others do so.

Egrets and herons eat many crawfish. Crawfish destroy young fish; they also burrow into dykes, and thus become at times a serious menace to the levees of the lower Mississippi. In recent years, since the great destruction of egrets in the southern States, immense damage to crops by crawfish has been reported from Alabama and Mississippi, where over a wide stretch of country "estimated at not less than 100 square miles, they have prevented to a very considerable extent the successful production of cotton and corn." [1] Can this be a mere coincidence?

The National Association of Audubon Societies made an examination of the stomach contents of young herons and egrets. The results, tabulated below, prove these birds to be destroyers not only of crawfish but also of insect pests.

Food of Young Herons.

[Based on the examination by O. E. Baynard, Orange Lake, Florida, of 50 meals of each of the following species.]

Species.	Grass-hoppers.	Cutworms.	Crawfish.	Suckers.	Mis-cellaneous Objects.
Snowy egret, ...	762	91	29	–	9
Little blue heron, . . .	1,900	149	142	–	45
Louisiana heron, . . .	2,876	17	67	–	14
Egret, ...	–	–	176	61	297[2]

Young herons have a very accommodating and hospitable habit of presenting their food to visitors by regurgitation after they have eaten it, and adult birds when suddenly frightened or disturbed often drop food from their bills. It is easy, therefore, to make a rather comprehensive survey of their food in the heronry without actually killing the birds. In 1915 fishermen on the Massachusetts coast complained that black-crowned night herons, which had increased under protection for several years, were catching so many eels that they were endangering

[1] Fisher, A. K.: Crawfish as Crop Destroyers, Yearbook, United States Department of Agriculture, 1911, p. 322.

[2] Frogs.

the eel-fishing industry. In 1916, at the suggestion of Mr. William C. Adams, then chairman of the Massachusetts Commissioners on Fisheries and Game, I visited three large heronries and collected and examined much partially digested material. The food consisted largely of fishes not considered of much value for human consumption, the principal species being the alewife. At a heronry on Cape Cod most of the food consisted of squids. The only valuable food fishes found were one eel and one pickerel.

Under the circumstances these herons could not be considered as detrimental to the fisheries at that time. Whether or not they were beneficial depends largely on the food habits of squids at that place and season. Squids destroy quantities of herring spawn. Probably all American herons and bitterns attack grasshoppers and locusts, and such caterpillars as cutworms and army worms, whenever these insects become numerous in or near their haunts. The larger species destroy field mice also.

The brown pelican on the Florida coast lives mainly on menhaden, an inedible fish, and both the brown pelicans and white pelicans on the western plains feed more or less on grasshoppers and locusts when these destructive insects are abundant. The notion that fish-eating birds are seriously destructive to food fishes arises from the fact that birds are conspicuous when fishing, while porpoises, predatory fishes and other creatures that devour food fishes and their eggs and young work mainly beneath the surface, out of sight. Probably most if not all fish prey on other fish or their spawn, and if we were to attempt to increase the supply of valuable fish by killing off their enemies, we should have to destroy most of the denizens of the ocean.

As an example of the useful habits of fish-eating birds, we may note those of the fish ducks, the sheldrakes or mergansers. These birds at times feed more or less upon trout, but they also destroy the enemies of trout. Minnows are eaten by mergansers, and minnows are said by good authority to devour large numbers of trout eggs. Trout fry, too, are destroyed by mosquitoes, which pierce the brains of the little fry when the latter come to the surface and leave them floating dead upon the current; but quantities of mosquito larvæ are destroyed by

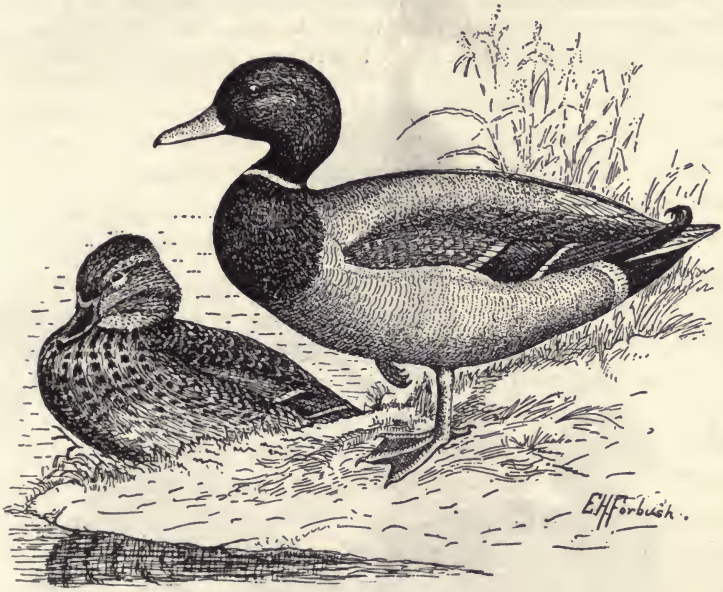
ducks which doubtless thus save many young trout. The influence of fish-eating birds is exerted to keep the balance true between the fish and their enemies, and to prevent any undue increase of either. If an increase of minnows or mosquitoes occurs then the ducks are likely to eat more and more mosquitoes or more minnows, or they may eat more trout if the trout are unduly numerous. This explains why fish-eating birds may be very destructive to artificially raised trout, which are kept in small ponds in numbers far exceeding those normally bred in equal space in the streams.

We sometimes hear complaints from fishermen that scoters (commonly called coots), or other diving ducks, are destroying shellfish and thus injuring the shellfish industry. But these ducks feed only on very small shellfish, never on marketable ones. They cannot swallow the larger ones. Moreover, Dr. G. W. Field, formerly chairman of the Massachusetts Commission on Fisheries and Game, and now (1921) in the fisheries service of Brazil, informs me that the thinning out of young clams which is accomplished by these birds tends to promote the rapid growth of those that are left, so that they more quickly reach marketable size. At first the clams are often so numerous that they have neither sufficient room nor food to develop. He also assures me that these ducks feed on destructive enemies of shellfish. Though possibly harmful at times, probably these birds are indispensable to the prosperity of the shellfish industry.

If we consider the fact that mosquitoes and flies are among the most dangerous enemies to the life and health of mankind because they carry and spread the germs of weakening and even fatal diseases, we shall more readily appreciate the services of birds in destroying these insects. The common house fly disseminates on human food the germs of typhoid fever, tuberculosis and other diseases. Many birds, particularly poultry and game birds, feed on fly larvæ. Mosquitoes infect people with the germs of malaria and yellow fever. Because of this distribution of such diseases by insects, great tracts of fertile land are rendered uninhabitable to white men, many deaths occur annually, and there is an enormous yearly economic loss through illness and death. Many birds destroy mosquitoes or their larvæ; among these the shore birds and wild-fowl stand pre-

eminent. The people of the State of New Jersey for years and years industriously killed off wild-fowl and shore birds for the market. Now they are on record as spending $3,500,000 a year in fighting mosquitoes.[1] But New Jersey is not alone, either in such killing or in such subsequent expenditure.

Probably most surface-feeding ducks that get a large part of their summer food about the margins of ponds and pools destroy incalculable numbers of mosquitoes by eating the larvæ which abound in such places. Dr. Samuel G. Dixon, commis-



THE MALLARD.

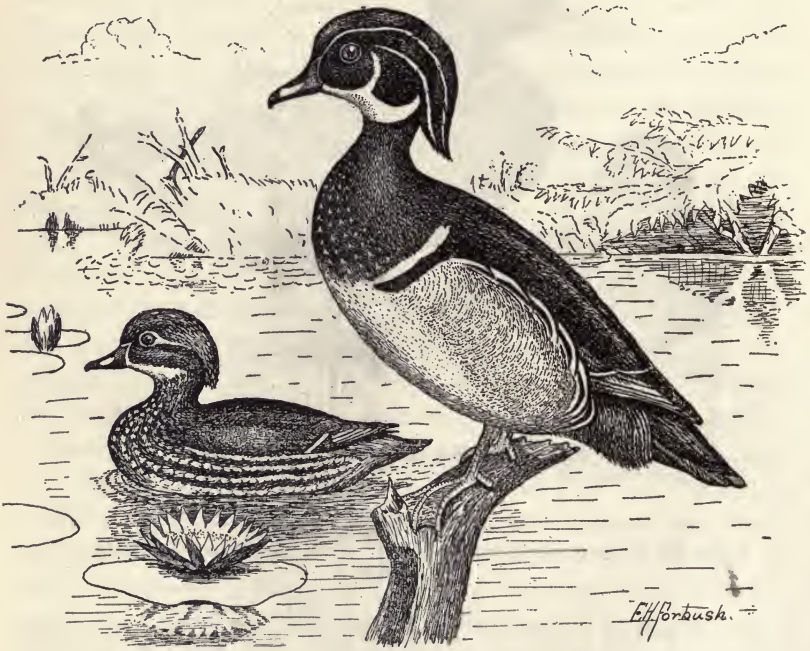
A destroyer of disease-distributing mosquitoes. (From Game Birds, Wild Fowl and Shore Birds.)

sioner of public health in Pennsylvania, writes that for some years he has used ducks to keep down mosquitoes in swamps that were difficult to drain, but that he never fully appreciated the high efficiency of the duck as a destroyer of mosquito life until he made the following test in a swamp after several unsuccessful attempts to destroy the mosquito larvæ by introducing fishes. He divided the swampy area into two equal parts, each about 1,400 square feet in extent. One pond was

[1] Washburn, F. L.: Fins, Feathers and Fur, June, 1915, p. 7.

stocked with goldfish, and the other was left as a feeding ground for ducks. Both were ideal as breeding places for mosquitoes. Where the fish had been introduced mosquito larvæ continued to flourish; but soon in the other pond there were no larvæ to be found. He then put ten mallard ducks into the fish pond, and within forty-eight hours only a few larvæ were left. The following letter commenting on this experience is of interest to all who suffer in summer from a pest of mosquitoes: —

Corroborating Dr. Dixon's interesting report on the duck as a preventative against malaria and yellow fever (Journal, American Medical Association, October 3, 1914, p. 1203), I have been observing the food of the



Wood Duck.

One of the most useful native ducks which destroys mosquitoes. (From Game Birds, Wild Fowl and Shore Birds.)

wild duck for the past three years, and find that the mosquito and larvæ are readily devoured by the duck. I have eight varieties under observation, and note that the best insect destroyers are the beautiful wood ducks (*Aix sponsa*), and the green-winged teal (*Nettion carolinensis*). These ducks are smaller than the mallard (*Anas platyrhyncos*), and their diet

more insectivorous. The wood duck is almost extinct except in captivity.[1] It is the most beautiful of all the duck family; therefore the introduction of this bird would help to perpetuate its kind, and also be of use in keeping down all noxious aquatic insect life. — Wm. C. Herman, Instructor in Pharmacology, Medical College of the University of Cincinnati.[2]

Gulls and terns that breed on islands in inland lakes are effectual destroyers of many insect pests. In many parts of the world gulls follow the plow and pick up grubs, wireworms, etc., that are found in the upturned soil; gulls also greatly assist in checking irruptions of destructive field mice and other small rodents.

Terns and some other sea birds aid fishermen by guiding them to schools of food fish. The birds find schools of small surface fish on which larger marketable fish feed, and by flocking to feed on little fish the birds point out to the watching fishermen the places where they must cast their nets. Both seine fishermen and line fishermen watch these birds closely, and often are guided largely by the actions of the gathering flocks. Gulls and terns serve also to guide mariners in foggy weather along dangerous coasts. These birds breed in large colonies on isolated islands. Navigators of coasting craft know well the locations of these islands and their position in relation to the channels. In thick fog a vessel often stops at certain points until the listening navigator can hear the cries of the breeding birds on some well-known island. These cries, by giving warning of the rocks and locating their direction, enable him to correct his course. In summer fogs longshore fishermen often verify their courses by watching the undeviating flight of terns flying to some well-known island with food for their young.

Dr. Frank M. Chapman has shown, in an interesting paper on the ornithology of the first voyage of Columbus, that we possibly owe the discovery of America by Columbus to the fact that he happened to approach the land at the right time and place to cross the line of the autumnal flight of birds that were flying from the Bermudas to the Bahamas and Antilles. The

[1] Since this was written laws protecting the wood duck have been passed, and the species has increased considerably in numbers in some parts of the United States.

[2] Journal of the American Medical Association, October 17, 1914, p. 1410.

discouraged seamen were on the verge of mutiny, and might have compelled Columbus to return to Spain, had not some small land birds finally come aboard unwearied and singing. The course of the vessel was changed to follow the direction of their flight, and the voyage was thus shortened 200 miles and ended in the discovery of a new world.[1]

Cash Value of Birds' Services.

Many calculations have been made to determine the actual cash value of birds to the farmers, but, owing to the many factors to be considered, such figures in the nature of the case may invite criticism. Dr. W. T. Hornaday asserts that each woodpecker in the United States is worth $20, and each nuthatch or chickadee from $5 to $10,[2] but he does not tell us how he arrives at these figures.

On December 12, 1907, President Roosevelt sent a message to Congress transmitting a report of the Secretary of Agriculture on the work of the Biological Survey. In this report it is estimated that a single species, Swainson's hawk, a bird inhabiting only a limited region in the western United States, saves the farmers of that country $57,600 each year by destroying grasshoppers, and this is by no means the most common or most useful of American hawks. After the breeding season these birds collect in large flocks on the western plains, where they feed mainly on grasshoppers, locusts and crickets.[3] Including the field mice that they eat, these hawks are estimated to save the western farmer $117,000 annually.

In 1885 the State of Pennsylvania passed a bounty act under which in a year and a half $90,000 were paid mainly for the destruction of hawks and owls, the bounty being 50 cents each. Dr. C. Hart Merriam, then chief ornithologist and mammalogist of the United States Department of Agriculture, estimated the value of the chickens killed annually in Pennsylvania by hawks and owls in a year and a half to be $1,875, and showed that the State of Pennsylvania had paid out $90,000 to save its farmers a loss on poultry of less than $2,000. His figures also showed that each hawk and owl was worth on the average $20 a year

[1] Papers presented to World's Congress on Ornithology, 1896, p. 181.
[2] Hornaday, W. T.: Our Vanishing Wild Life, 1913, p. 213.
[3] Sixtieth Congress, First Session, Senate Document No. 132, 1907, p. 3.

to the farmers of the State as a destroyer of mice and insects. He therefore estimated that the pests left alive by the destruction of 128,571 hawks and owls had cost the people of the State in that year and a half $3,850,000 in addition to the $90,000 paid out in bounties. Dr. Merriam's eminent position as a scientist lends weight to his estimates.

A Michigan man boasts of having killed over 4,000 hawks, and publishes his photograph together with those of 11 dead hawks nailed to a barn door, all killed by him in one day.

Mr. J. Warren Jacobs observing this photograph is led to remark that nearly three-quarters of the prey of the red-shouldered hawk consists of field mice, and almost all the remaining fourth consists of insects. This report is based upon examinations of the stomachs of many hundreds of specimens by naturalists in different parts of the United States, and particularly on examinations made by the Biological Survey of the United States Department of Agriculture. Mr. Jacobs says that —

> The sacrifice of these 11 red-shouldered hawks, in one day, spared the lives of possibly, if not actually, 77 field mice daily (7 for each hawk), or 28,105 during the year. Each of these 28,105 mice would have devoured one-half ounce of grass tendrils and rootlets daily, totaling 878 pounds, or the equivalent of one-half that much hay or pasture grass in a day, equaling 239 pounds, or 43½ tons in one year. The value of 43½ tons of hay is about $696. Thus each of these 11 hawks would have prevented the destruction of $63 worth of hay by mice in one year. To these figures should be added $15 saved by each hawk in destroying other mammal pests and insects.[1]

These hawks, says Mr. Jacobs, are called chicken hawks, but do not deserve the name, for less than 4 per cent of their food consists of poultry and game birds.

Mr. C. C. Clute relates the following instance of money saved through attracting birds: —

> I know one farmer in particular who lost during one summer three rows of corn 40 rods long. The corn grew next to a fence-row heavily sodded with bluegrass, which produced swarms of grasshoppers. For the sake of the experiment alone, for this farmer was a skeptic, last spring he put up 21 bird houses, placed 2 rods apart, on the fence along the 40 rods. The houses were some that he and the boys had made, during the winter

[1] Jacobs, J. Warren: Observations by the Way, Waynesburg, Pa., Feb. 18, 1916. (Apparently Mr. Jacobs, figures are too low and the quantity of hay should be doubled.)

months, from dry goods boxes obtained in town. Thirteen of the 21 houses were inhabited during the following summer, 6 by wrens, 4 by bluebirds, and 3 by colonies of purple martins. The grasshoppers that summer made a rich living for the birds, and when the fall came that farmer had the satisfaction of gathering 23 bushels of corn from the three rows that grew next to the fence, right where there had been no corn at all the year before. With corn selling at 55 cents per bushel, it represented a saving of $12.65 for that year alone, and with the same insurance for the following year with no outlay at all.[1]

The most recent investigation regarding the cash value of a bird is that of Dr. Gross, who makes the following estimates in regard to the dickcissel or black-throated bunting. He has studied the food of the young of the dickcissel and also the food of the adults. He noticed that from the fifth day until the young left the nest their food was practically all grasshoppers. These grasshoppers were taken from a near-by clover field which was overrun with them. During the last days spent by the young in the nest, grasshoppers were fed to them at the rate of one every three or four minutes. A conservative estimate indicates that about 200 grasshoppers were eaten each day by the two adult birds and their four young. Dr. Gross says that if each dickcissel family averages as well as these birds, then the more than a million dickcissels in Illinois destroy about 100,000,000 grasshoppers in a day during this period of the nesting season. Since each grasshopper, according to an estimate made by Professor Lawrence Bruner, entomologist of the Nebraska Experiment Station, consumes about one and one-half times its own weight, or about .05 ounce of grass a day, then 100,000,000 grasshoppers would destroy about 156 tons daily. The price of hay during the summer of 1918 was about $30 a ton; therefore the dickcissels of Illinois during the active period of the nesting season saved the people of the State about $4,680 daily by the destruction of grasshoppers alone.[2]

Mr. W. L. McAtee, the eminent economic ornithologist of the Bureau of Biological Survey, United States Department of Agriculture, says that investigation has shown that most birds are beneficial, although in varying degrees, and that only four or five species in the United States are consistently injurious.

[1] Iowa Conservation, January–March, 1917, Vol. I, No. 1, p. 12.
[2] Gross, Alfred O.: Auk, Vol. XXXVIII, No. 2, April, 1921, p. 166.

Taking numerous bird censuses as a basis he asserts that it is practically certain that there are nearly 4,000,000,000 breeding birds in the United States each summer. The great majority of the birds of the United States are migratory, and those which are purely migratory in this country, breeding in northern North America, probably equal or surpass the population of our breeding birds.

Mr. McAtee estimates the value of each bird as an insect eater at 10 cents a year, which he himself admits is a ridiculously low figure. Then, estimating the value of the purely migratory species as one-sixth of that of the breeding species (both resident and migratory), he asserts that without the services of the birds the yearly bill for insect injury in the country would be more than $444,000,000 greater than it now is. This sum is more than one-third of the latest estimate of the total annual damage by insects in the United States.[1]

Utility of Birds in War.

All humanitarians hope that wars will cease, and perhaps, in time, during the evolution of the race, human nature will become so changed that such wholesale murder will be abolished, but probably no man now living will see that day. So long as we have war the services of birds in war should be recognized. In the recent great struggle which involved more than half the world, the keen senses and powerful flight of birds were used to great advantage.

When the great German airships began to raid England, pheasants and other birds heard or saw them coming at great distances, and gave the alarm by their insistent cries long before human eyes or ears could discern their approach.

In the trenches great numbers of canaries were used to detect the first approach of poison gas before it became apparent to the less subtle senses of man. The distress of the little birds gave timely warning to the soldiers that it was time to don the gas masks.

Submarines and mines often were detected by watching the behavior of sea gulls which, owing to the height at which

[1] Speech of Congressman S. D. Fess of Ohio on the Federal Migratory Bird Treaty Act, Congressional Record, Sixty-fifth Congress, Second Session, Vol. 56, No. 146, June 14, 1918, p. 7956.

they flew above the water, could readily see the submerged submarine boats which they followed for the sake of the garbage which all boats must discharge into the sea. Lookouts from both destroyers and airplanes watched the movements of the gulls, and by so doing sometimes located the submerged enemy. Mines, escaping from their moorings, floated on the sea and formed a danger which could only be met by extreme vigilance. Gulls frequently perched and rested on the arms of these floating mines and so called attention to them and saved ships that otherwise might have been destroyed.

During the war the chief countries of the world were combed for carrier pigeons. Wherever on the battlefields a heavy "barrage" of exploding shells was laid down, breaking the wires and disabling the runners by whom communication was kept up with headquarters or with the batteries, carrier pigeons were sent out, if available, with messages, and they conveyed a very large percentage of those messages safely through the hell of shellfire, despite the fact that shotguns were often used by the enemy to bring down the birds.

The crew of a mine sweeper sunk by a submarine were saved by a pigeon messenger which, sent by the dying captain, reached its loft, though wounded and dying, in time to bring a swift destroyer to the scene. The crews of seaplanes broken down and wrecked at sea were saved by timely messages carried by these birds which brought them speedy assistance. A German submarine base was discovered on the coast and a pigeon messenger carried the news in time to bring destroyers to capture the U-boats. This very brief and imperfect account of the utility of birds in the great war is sufficient to show that their services were not only valuable but essential.

Commercial Value of Birds.

The commercial value of birds to man is incalculable. From time immemorial birds have furnished both savage and civilized man with a considerable part of his food; and since the marts of trade have become established, the flesh, eggs and feathers of birds have had a large place in trade and commerce. Birds always have had a prominent place in the game markets of all civilized lands.

Early Abundance of Game Birds.

When the Pilgrim Fathers settled at Plymouth in 1620, this country was a vast breeding ground of game birds and mammals. The elk, moose, deer, and the bison or buffalo, roamed the land in countless numbers. Multitudes of wild turkeys and many millions of grouse and quails were found on mountain and plain. Pigeons sometimes filled the air with their amazing myriads, hiding the sun, and in migration passed over the sky in constant streams and in astounding numbers. Plovers, snipes, curlews and sandpipers were so abundant that at times the very soil of the Mississippi valley seemed to be alive and moving with their feeding hordes. They swarmed on the Atlantic coast, the islands of the sea, and even on the shores of the Great Lakes in innumerable multitudes, while countless numbers of waterfowl breeding over half the area of what is now the United States, and over nearly all of what is now British America, gathered in innumerable hordes, sweeping over the country in the autumnal and vernal migrations.[1] A similar abundance of game birds once existed in nearly every land.

Game Birds as Food.

In the early days in America game was of little value commercially, and many a hunter would not waste ammunition on anything smaller than a bear, a deer or a wild turkey. But from the very first settlement, wild turkeys, geese and other waterfowl, grouse and pigeons formed a considerable part of the food of the settlers. Such an abundant source of nourishing food never was neglected, and as the large game diminished and disappeared before the advance of civilization, the game birds became relatively more important as a food supply for the growing population. During the early settlement of the country there were no markets, and when grouse were first sold they brought but 1 copper cent each, while even as late as Audubon's time wild turkeys might be bought in the west for 25 cents apiece. But as the birds decreased in number and the demand increased, prices were correspondingly raised. As civilization

[1] Game Birds, Wild-Fowl and Shore Birds, Massachusetts State Board of Agriculture, 1916, Introduction.

extended over the great west, and railroads spanned the country, game birds became a great commercial asset, and were pursued and exploited with such vigor that in time some of them became nearly extinct and a few species wholly disappeared. Considering the vast supply of game formerly sold in the markets of the United States, very few figures relating to the game business are available to-day.

Dr. D. G. Elliott asserts that a game dealer in New York received 20 tons of prairie chickens in one consignment in 1864, and that some of the larger dealers sold from 150,000 to 200,000 birds in six months. Professor Samuel Aughey, who gathered statistics regarding the destruction of bobwhites and pinnated grouse, or prairie hens, in Nebraska from 1865 to 1877, asserts that about 450,000 of these birds were killed each year in thirty counties of Nebraska alone. Game Commissioner John H. Wallace, Jr., of Alabama says that before the present game laws of his State were enacted no less than 9,000,000 bobwhites were killed there in one season. In "Forest and Stream" of March 11, 1912, the assertion is made that on February 18, 9,000 bobwhites in one illegal shipment were seized by a sheriff and a game warden in Oklahoma.[1]

In 1909, when the sale of game was at its height, President Frank M. Miller of the State Game Commission of Louisiana was able to get rather accurate figures of the game birds killed that year in that State. They totaled 5,719,214. The exploitation of the passenger pigeon, once on its roosting places and on its nesting grounds perhaps the most numerous bird ever known in any country, and now believed to be extinct, will serve to illustrate the commercial value of game birds. This bird was a great source of food supply to the early settlers, who took large numbers in nets. With the growth and prosperity of cities, quantities of pigeons came into the city markets. Audubon says that in 1815 he saw schooners at the wharves in New York loaded in bulk with these pigeons, killed up the Hudson River. From that time the trapping, netting and shooting of the pigeons went on apace until 1878, when Professor H. B. Roney estimated, after examining the ground and the market shipments, that at least 1,000,000,000 pigeons were

[1] Game Birds, Wild-Fowl and Shore Birds, Massachusetts State Board of Agriculture, 1916, p. 514.

killed in Michigan that year.[1] It is generally believed, however, that this was an overestimate. But Mr. Sullivan Cook says that in 1869 for about forty days there were shipped from Hartford, Michigan, and vicinity three carloads a day of 150 barrels each; at 55 dozen pigeons to the barrel, this totals 880,000 birds for the season. He estimates that in two years 15,840,000 were shipped from Shelby, Michigan. Again, five years later, Mr. C. H. Engle asserted there were shipped from Petoskey, Michigan, five carloads a day for thirty days, with an average of 8,250 dozens to the carload, or 14,850,000 birds.[2]

Hunters and netters followed the pigeons to every known roost and nesting place until the species was nearly extinct. The destruction of the golden plover, upland plover and Eskimo curlew was brought about by the market demand, but the birds were mostly shot. Audubon asserts that on the sixteenth day of November, 1821, he was invited by some gunners to accompany them to the neighborhood of Lake St. John, near New Orleans, there to observe the flight of thousands of golden plovers. The gunners were familiar with the route that the plovers ordinarily took. The men gathered in parties of from 20 to 50, and sitting on the ground, equidistant from each other, imitated calls of birds so that the plovers came within a few yards. Audubon, having reckoned the number of gunners in the field, and estimating the average number shot per man during the day at 20 dozen birds, calculated that 48,000 golden plovers were killed there that day. Two men on the Island of Nantucket in the decade between 1840 and 1850 killed for market enough plovers and curlews in one day to fill a tipcart two-thirds full.[3] From Audubon's time until the approach of the extinction of the passenger pigeon in 1888, golden plovers and Eskimo curlews were shot by sportsmen both east and west in enormous numbers.

When the passenger pigeon became so scarce that it was difficult for the pigeon netters to find employment for their men, the marketmen turned to the supply of Eskimo curlews, golden plovers and upland plovers, that were still numerous in

[1] American Field, Vol. X, pp. 345-347.

[2] Mershon, L. B.: The Passenger Pigeon, 1907, pp. 171, 172; see also Game Birds, Wild-Fowl and Shore Birds, Massachusetts State Board of Agriculture, 1916, p. 454.

[3] Game Birds, Wild-Fowl and Shore Birds, Massachusetts State Board of Agriculture, 1916, p. 344.

the west. In one year alone (1890) two Boston firms received from Nebraska, Missouri and Texas 40 barrels closely packed with these birds.[1] Similar shipments continued to arrive in the large cities, with the result that during the latter part of the nineteenth century or early in the twentieth, the Eskimo curlew became practically extinct, and the upland plover and golden plover were well on the way to extinction.

As game birds became scarce small birds appeared in many markets. In 1902, 42,059 "game birds" were seized in a cold-storage house in New York City, 8,058 of which were found to be snow buntings, 7,607 sandpipers and 288 bobolinks.[2] Mr. James Henry Rice, Jr., says that 720,000 bobolinks were shipped to market in one season from Georgetown, South Carolina, and countless numbers of small birds were sold in other southern markets.

Dr. P. P. Claxton of the University of Tennessee tells of a robin roost near Forest Hills in that State where robins were dazed by torchlight night after night and killed by hundreds.[3] Dr. Hornaday says that one small hamlet in Tennessee sent to market yearly about 120,000 dead robins.[4] During the last part of the nineteenth century song birds in great numbers were sold openly in southern markets. At that time practically all the game birds in the United States were menaced with extirpation, but during the second decade of the twentieth century State laws were passed prohibiting the sale of wild game. Such laws were not only enacted by most of the States, but more recently a regulation forbidding sale of migratory game birds was finally promulgated by the Secretary of Agriculture, under the Federal Migratory Bird Treaty Act, thus making illegal the sale of all native game birds in the markets of the United States, except such as under proper restrictions may be raised on game farms and game preserves. The rearing of such birds under such conditions may eventually restock the markets of the country with game.

The great demand for game both in this country and Europe has much depleted the supply of the world's game birds.

[1] Mackay, George H.: Auk, Vol. VIII, No. 1, 1891, p. 24.
[2] Hornaday, W. T.: Our Vanishing Wild Life, 1913, p. 68.
[3] Pearson, T. Gilbert: Bird-Lore, Vol. XII, No. 5, September–October, 1910, p. 208.
[4] Hornaday, W. T.: Our Vanishing Wild Life, 1913, p. 108.

ALBATROSSES ON LAYSAN ISLAND, H. I.

A breeding place of sea birds, where cars have been loaded with eggs and hundreds of thousands of birds have been killed for their feathers. (Photograph by J. J. Williams, Honolulu.)

Pheasants from India, quails from Africa, tinamous from South America, lapwings and grouse from Europe, and other species have appeared in numbers in the principal markets of the world, and to-day some species of pheasants are almost extirpated from their native land. If the sale of foreign game continues many species may become extinct.

Eggs of Sea Birds as Food.

Water birds, such as auks, murres, pelicans, gulls, terns, ducks and herons, breed in communities on islands in lakes or along the coasts of all the continents. For centuries it has been the common custom for men to visit these colonies at the beginning of the nesting season, break all the eggs to insure a supply of fresh ones, and then about every alternate day to gather all the new-laid eggs for food. As market demands grew apace, this egg gathering became a regular business. On the Atlantic coast of North America, during the latter part of the last century, all eggs from an inch in diameter upward, from Labrador to Texas, were taken and sold to consumers or in public markets. When settlement reached the coast of the Pacific the eggs of sea birds which formerly had been taken in some numbers by the Indians were exploited by the whites. Some idea of the enormous numbers of eggs gathered may be gained from the statement of H. W. Elliot, that when he first visited Walrus Island in Behring Sea in July, 1872, six men in less than three hours loaded to the water's edge with murres' eggs a small vessel of 4 tons' capacity. Egging was carried on as a business for nearly fifty years in the Farrallone Islands off the coast of California. Myriads of sea birds, chiefly gulls and murres or California guillemots bred on these islands. The eggs were collected and sold in the markets of San Francisco at from 12 to 20 cents a dozen during a season of about two months. It is said that between 1850 and 1856 three to four million eggs were marketed from these islands. On Laysan Island, one of the Hawaiian group, the eggs of thousands of albatrosses nesting there were collected and loaded on the cars of a narrow-gauge railway and eaten by laborers engaged in shipping guano from the island. It was customary in most

localities along the coast of North America to allow the birds to hatch some eggs late in the season, but the disregard of this custom in many instances, and the wholesale killing of the birds, destroyed or greatly reduced many of the colonies along the Atlantic and Gulf coasts. Unrestricted egging was responsible for a good part of the great diminution of sea birds in Labrador. Audubon's story of the Labrador eggers published in his "Ornithological Biography" clearly exhibits terrible destruction among sea birds on the Labrador coast early in the nineteenth century. The business was finally forbidden by law both in the United States and Canada, but some illicit egging is carried on still, even in regions that receive special protection by wardens.

Feathers of Sea Birds and Wild-fowl for Bedding.

In the colder countries of the world the feathers and down of waterfowl have been in great demand for centuries as filling for beds and pillows. Such feathers are perfect non-conductors of heat, and beds, pillows or coverlets filled with them represent the acme of comfort and durability. The early settlers of New England saved for such purposes the feathers and down from the thousands of wild-fowl which they killed, but as the population increased in numbers the quantity thus furnished was insufficient and the people sought a larger supply in the vast colonies of ducks and geese along the Labrador coast. The manner in which the feathers and down were obtained, unlike the method practiced in Europe, did not tend to conserve and protect the source of supply. In Iceland the natives have continued to receive for many years a considerable income by collecting eider down, but there they do not "kill the goose that lays the golden eggs." Ducks line their nests with down plucked from their own breasts, and that of the eider is particularly valuable for bedding. In Iceland these birds are so carefully protected that they have become as tame and unsuspicious as domestic fowls. In North America, where they are constantly hunted, they often conceal their nests in the midst of weeds or bushes; but in Iceland they make their nests and deposit their eggs in holes dug for them in the sod,

near the huts of the inhabitants, or even on the sodded roofs of these huts. When the first downy lining is removed from the nest by the collectors the bird replaces it with more down from her breast. If the second lining is taken it is said that the male bird then contributes a third. The people never disturb the nest after this, but allow the birds to hatch their eggs and rear their broods unmolested. Thus a supply of the ducks is maintained so that the people derive from them an annual income.

In North America quite a different policy was pursued. The demand for feathers became so great in the New England colonies about the middle of the eighteenth century that vessels were fitted out there for the coast of Labrador for the express purpose of securing the feathers and down of wild-fowl. Eider down having become valuable, and these ducks being in the habit of congregating by thousands on barren islands of the Labrador coast, the birds became the victims of the ships' crews. As the ducks molt all their primary feathers at once in July or August, and are then quite incapable of flight, and the young birds are unable to fly until well grown, the hunters were able to surround the helpless birds, drive them together and kill them with clubs. Otis says that "millions" of wild-fowl were thus destroyed, and that in a few years their haunts were so broken up by this wholesale slaughter and their numbers were so diminished that "feather voyages" became unprofitable and were given up.[1] This practice (followed by the almost continual egging, clubbing, shooting, etc., by Labrador fishermen) may have been a chief factor in the extinction of the Labrador duck, that species of supposed restricted breeding range. No doubt had the eider duck been restricted in its breeding range to the islands of Labrador, it also would have been exterminated long ago. After the failure of the Labrador feather voyages the American market was supplied with the feathers of domestic geese and with eider down imported from Europe.

[1] Otis, Amos: Genealogical Notes of Barnstable County [Massachusetts], Vol. I, 1885, p. 187.

Feathers for Ornament.

In the midst of modern civilization we still cling tenaciously to rings, beads and feathers, the ornaments of the savage. The trade in feathers for adornment has grown to such enormous proportions that it has furnished employment or partial employment to hundreds of thousands of people; and the profits made from the handling, dyeing, "manufacture" and sale of feathers have run into millions, if not billions of dollars. Birds of all sizes have contributed their feathers to fashion's demands, from the lowly duck or chicken of the farmyard to the giant ostrich, and from the tiny hummingbird, warbler or kinglet to the regal bird of paradise, the snowy-plumaged egret, the royal eagle, the giant condor or the long-winged albatross. This trade has gone on, recklessly slaughtering and exterminating the birds of the world, until public sentiment has attempted to call a halt in many countries, protecting the birds by law, and forbidding the exportation or the importation of plumage. Wardens armed with rifles have been placed on guard over protected bird colonies. Still the slaughter, though checked to some extent, goes on. Tons of feathers are smuggled out of one country and into another, and there is always a supply at hand for woman's adornment. The scarcity of some feathers and the difficulty of smuggling them has increased their value in the retail market to much more than twice their weight in gold.

During the last century there was a great demand for swan's down, which sold at high prices and was used for trimming fine fans, cloaks and other articles for women's wear or adornment. This traffic contributed largely toward the threatened extinction of the trumpeter swan, the pitiful remnant of which the Canadian authorities are now trying to save. We have no record of the early trade in swan skins, when the trumpeter swan was abundant and bred widely in the Athabasca-Mackenzie region, but the number sold annually by the Hudson Bay Company decreased from 1,312 in the year 1854 to 122 in 1877. In 1899 the Athabasca output had dwindled to 33 skins.[1] The trumpeter swan is now nearly extinct.

[1] Preble, E. A.: North American Fauna, No. 27, Bureau of Biological Survey, United States Department of Agriculture, 1908, pp. 309, 310.

It hardly seems possible now that within fifty years the skins of bluebirds, tanagers, orioles and even swallows were in demand in Massachusetts and were used in some quantities as millinery ornaments. Within forty years the egrets of the United States have been almost exterminated, and the gulls and the terns of the Atlantic coast so reduced in numbers that at least two species have been nearly extirpated. When I was in Florida in 1878 immense numbers of egrets were seen in the swamps and on the lakes, rivers and lagoons of the southern counties. Even then the plume hunters had begun their nefarious work, and ten years later the egrets were nearly all gone. A remnant of their former vast numbers has been saved by the wardens of the National Association of Audubon Societies. The inhuman and revolting cruelty of this business should have brought about its abolition by the indignant protest of the public. The birds were shot on or near the nests, the plumes torn from their bleeding backs and the helpless young left to starve.

Terns were shot down all along the Atlantic coast, and often their wings were cut off, while the suffering birds were still alive. Half-naked savages were furnished with cheap guns and sent into swamp and forest fastnesses in all parts of the world, wherever birds of desirable plumage could be obtained. Mr. A. H. Meyer of New York testified that he had seen plume hunters in Venezuela tear the plumes from living wounded egrets, leaving them to die of starvation, unable to respond to the cries of their starving young in the nests above. He said that he had seen heartless plume hunters tie and prop up wounded birds as decoys, to attract others, until the terrible red ants of the country had eaten out the eyes of these wounded living but helpless birds. In 1909 a band of Japanese, headed by a German adventurer, raided Laysan Island, then a United States government bird reservation, and before they were discovered and apprehended they had killed more than 259,000 birds. There were 259,000 pairs of wings found in the hold of their vessel, with $2\frac{1}{2}$ tons of feathers, also some large cases and several boxes of stuffed birds.[1] Many of the albatrosses taken were so fat that the skin and feathers were likely to be injured

[1] Pearson, T. G.: The Bird Study Book, 1917, p. 141.

by fatty matter after their removal from the birds. A large number of these birds, therefore, were imprisoned in a great dry cistern, where they were starved to death to reduce the fatty tissue and save trouble in cleaning the skins. When the revenue cutter "Thetis" arrived there were acres of dead bodies and bones, and about three carloads of wings, feathers and skins. All the latter were seized, with the exception of a shed full of wings which were left behind for lack of space to carry them on the ship.[1] The power of the United States government was not sufficient to protect the islands from another similar raid later by Japanese, and it is said that practically all the bird islands in the Pacific at a distance from our coast are thus periodically raided.

Before the destruction of birds for millinery purposes in the United States was checked by law and public sentiment, enormous numbers of birds were destroyed. The millions of egrets in the country were reduced to a few thousands, and great quantities of grebes, nesting in western marshes, were slaughtered. No reliable estimate of the number of birds killed in the United States for millinery purposes has been made, but fragmentary reports may give the reader an idea of the extent of the slaughter and the money involved. About 70,000 bird skins were sent to New York from a small district on Long Island in about four months. A collector brought back 11,000 skins from a three months' trip. One New York firm had a contract to supply 40,000 skins to a company in Paris, France. A dealer during a three months' trip to South Carolina prepared 11,018 bird skins. A woman milliner went to Cobbs Island, Virginia, to get birds to fill an order for 40,000 bird skins. This order practically exterminated the terns then on the island. Mr. T. Gilbert Pearson, now (1921) president of the National Association of Audubon Societies, who compiled his figures from the records and accounts of the feather hunters, says that 500,000 terns were killed for millinery purposes on the Sounds of North Carolina and South Carolina in seven years.[2] Gunners were hired to kill the birds at 10 cents per bird. One auction room in London sold in three months 400,000

[1] Hornaday, W. T.: Our Vanishing Wild Life, 1913, pp. 139–141.
[2] The Bird Study Book, 1917, p. 141.

birds from America, and 350,000 from India, and this was only one of the many firms in this and other European cities engaged in this business.

After the trade in American birds was largely checked, great quantities of the skins and feathers of foreign birds continued to come into American markets. When in 1913 a clause prohibiting the importation of the plumage of wild birds was introduced into the new tariff bill then pending in the United States Senate, the Imperial German Chargé d'Affaires at Washington entered a protest, asserting that the proposed prohibition would entail a serious loss to the German industry of millinery feathers. He quoted returns from the Consulate General of the United States, showing that in five years the specified value of feathers exported to the United States from the Berlin district alone was $3,079,498.

The tentacles of this vast octopus, the plumage trade, reached into every land. A list of the wild birds slaughtered at its behest, many of them in danger of extermination, includes many of the most remarkable and beautiful of the feathered gems of the world. Australian lyre birds, South American rheas and resplendent trogons, the condor, — the largest bird that flies, — the wonderful and beautiful pheasants of India and China, the marabou stork of Africa, the bustards, crowned pigeons, egrets and ibises, and scores more from many parts of the world, are included in the list. This enormous remunerative trade will exterminate species after species, and when one is gone another will be used to take its place, unless public sentiment can be aroused to secure both the passage and enforcement of laws forbidding the possession and sale of the plumage of wild birds everywhere. The plumage of domestic fowls and that of game birds and ostriches raised on farms can be so "manufactured" as to take the place of that of wild birds, if women must wear feathers. The preparation of the feathers of poultry and ostriches is now an immense and well-recognized industry.

Shooting Birds for Sport.

Most of the hunting of game birds now going on in North America is done in the name of sport, although this sport sup-

plies much nutritious food; also it supports a great trade in guns, ammunition, boats, dogs, tools, clothing and other sporting goods. It furnishes employment to guides, dog breakers, gamekeepers, boatmen and professional hunters, and helps to maintain many country hostelries and seaside hotels. Many farmers receive money enough for the shooting privileges on their farms to more than pay their taxes. In England and Scotland, where there are many game farms and game preserves, the shooting privileges are valuable and the revenue from them is considerable. All told, many thousands of families derive part or all of their support from occupations connected with catering to the sportsman. The physical benefit which harassed business men derive from field sports is considerable, and undoubtedly many a useful life has been prolonged thereby.

Value of Birds in Domestication.

The domestication of birds has been of inestimable value to mankind from remote antiquity, and no doubt grew from the desire of the primitive agriculturist to have constantly at hand a delicate nourishing food supply. No other animals are capable of furnishing man with a similarly valuable supply of both meat and eggs. Thus far, excepting the ostrich, only such species have been domesticated as belong to those families which when wild are known as game birds and wild-fowl, and when domesticated, as poultry. These include chickens, turkeys, guinea fowls, peacocks, pigeons and doves, ducks, geese and swans. The immense value of these birds to mankind within historic times cannot be estimated. In the United States alone the annual worth of poultry products in 1907 had reached nearly $300,000,000, and they have more than trebled in value since that time. Mr. Alton E. Briggs of the Boston Produce Exchange quotes Mr. Marshall of the United States Bureau of Markets to the effect that in 1918 the fowls of the United States produced for market 2,500,000,000 dozens of eggs, and he asserts that these market eggs alone were easily worth over $1,000,000,000, to say nothing of the eggs used by the farmers themselves, or the vast quantity of valuable poultry produced and marketed. The worth of poultry products consumed annu-

ally in Massachusetts alone is estimated at $45,000,000 to $50,000,000,[1] and it is not improbable that the value of the annual poultry product of the world would reach $25,000,000,000. When it is considered that in all the centuries but few species of birds have been domesticated, only one of which, the turkey, originated in America, it seems probable that the possibilities of profitable domestication have not yet been exhausted.

Fertility from the Sea. — Immense Value of Guano Deposits.

Bird guano consists mainly of the excreta of fish-eating sea birds, in which are sometimes intermixed much smaller quantities of undigested or partially digested fish dropped or regurgitated by the birds, together with the remains of birds and sea lions and other mammals. The best guano comes from the Chincha Islands of Peru. In those nearly rainless regions it retains a large percentage of its nitrogen, and Dr. Robert Cushman Murphy remarks that, calculated according to the nitrogen content, the best Peruvian guano is more than thirty-three times as effective as barnyard manure.[2]

Centuries before the discovery of America there existed on the west coast of the South American continent a civilization noted for its agriculture, textile industries and architecture. The intensive agriculture of the Incas, upon which their civilization was based, was made possible by the deposits of guano, and through a wonderful system of agricultural engineering by which they laid out irrigation works which enabled them to extend their crop-producing industries far into the naturally arid wastes. Guano was used even on the mountain terraces two to three miles above sea level. The Incas wisely conserved the birds that produced guano. The breeding birds were zealously guarded, and the wanton destruction of one of them was made a capital offence, punishable by death. Unfortunately protective measures were not adopted by the whites, who, on the contrary, not only exploited the supply, but destroyed the birds that produced it. Humboldt returning from his travels in tropical America in 1804 carried to Europe samples of guano,

[1] Bulletin No. 1, Massachusetts State Board of Agriculture, 1917, pp. 6, 7.

[2] The Seacoast and Islands of Peru, Brooklyn Museum Quarterly, Vol. VII, No. 4, October, 1920, p. 245.

and first called attention to the value of the immense deposits on the Chincha Islands. The importance of this announcement was not realized at that time, but forty years later this same guano revolutionized methods in agriculture in all civilized lands, and furnished an immense source of revenue for exploiting corporations and even for nations. The Peruvian government depended largely for some years upon the revenue from this industry for the payment of the interest on the national debt.[1]

In 1843, when the great commercial extraction of guano from these islands began, the material lay in beds, in some cases more than 100 feet in depth. The supply seemed inexhaustible, and according to a survey made by the Peruvian government in 1853, there were 12,376,100 tons then available. By 1850 the price of Peruvian guano in the United States had advanced to $50 per ton or more. It is said that from 1851 to 1872 more than 10,000,000 tons of this excellent fertilizer were taken from one small group of islands, representing an average annual exportation valued at from $20,000,000 to $30,000,000.[2]

During this period the destruction of the birds and the extraction of the guano were carried on together. Sometimes as many as fifty or seventy ships of different nations were gathered around the islands. Slaves were employed to dig and load the product, while the birds were wantonly killed or driven away. At times thousands of young birds were driven over the cliffs to their death merely to get them out of the way. Such a campaign of destruction and exploitation could have but one end. Dr. F. A. Lucas asserts that as early as 1879, when he visited the islands, they had been swept clear of guano birds, and that he saw no sign anywhere on that coast of the huge flocks of those species of birds that had been responsible for the original guano deposits.

By the close of the last century the deposits on the islands were so reduced, that the agriculture of Peru itself was threatened. The control of the small remaining supply was largely in the hands of foreign creditors, and the future of the Peruvian guano industry looked dark indeed. Since then, however, the

[1] Palmer, T. S.: Yearbook, United States Department of Agriculture, 1899, p. 274.

[2] Coker, R. E.: Peru's Wealth-producing Birds, National Geographic Magazine, Vol. XXXVII, No. 6, June, 1920, p. 543.

government has adopted a wise system of conservation, including rigid protection of the birds. Thereby the greatest of all modern business undertakings based on the conservation and protection of wild birds, has been rapidly built up. The principal guano-producing birds of these islands are a species of cormorant, a pelican and two gannets. They are constantly guarded and protected from their enemies, and now (1921) have increased within twenty years from a miserable remnant to enormous numbers. It is estimated that there were in 1913 5,600,000 cormorants on the central Chincha Island alone. Under the present system the production of guano on these islands has risen from 25,370 tons in 1909–10 to 80,898 tons in 1917–18. In a letter dated August 24, 1920, Senor Ballen wrote that it was expected that the output for that year alone would be 82,000 tons. These figures refer not to the ancient or fossil guano, now entirely exhausted on these particular islands, but to the recent product deposited since the policy of conservation began. It is noted, also, that under this policy the average nitrogen content of the guano has risen nearly 4 per cent in the last five or six years. Dr. Coker estimates that the money value of a single pair of cormorants (*Phalacrocorax bougainvillei*) is not less than $15 for the guano that they produce.

For the above facts I am largely indebted to Dr. Murphy, who has recently investigated the Chincha Island guano industry on the spot. There are many other guano islands, but those in rainless regions are of the greatest value, losing little of the nitrogen content which, elsewhere, rain washes out. American citizens have filed claims to about seventy-five guano islands situated mainly in the Pacific or the Caribbean sea. On some of them deposits have proved worthless, but guano valued at more than $3,000,000 has been imported to the United States from some of these islands. Citizens of other countries have exploited other guano islands in various parts of the world, but the Peruvian Islands, under wise management, will continue to be the greatest guano-producing station in the world.

Here ends our survey of the value of birds to man from a material standpoint. What follows is taken in substance from "Useful Birds," with such changes as afterthought has dictated.

Esthetic, Sentimental and Educational Value of Birds.

Thus far in this bulletin birds have been regarded solely from the standpoint of "enlightened self-interest." They have been looked at strictly from the utilitarian point of view, and it has been demonstrated that their contributions to man's material welfare are very considerable. Now let us turn for a moment from the contemplation of such utility of birds as money can measure to "some of the higher and nobler uses which birds subserve to man."

At once we step from the beaten path of economic ornithology into a realm made sacred by art, letters, sentiment and poetry, — into intellectual fields where the fascinating study of birds may either provide delightful experiences or may lead to the classroom, the museum, the laboratory or the closet of the systematist. Wherever it may lead, this phase of our subject is important and demands the most serious consideration. Although presented last, its benefactions should be reckoned first among the items which go to make up the sum of our indebtedness to the feathered race.

The beauty of birds, the music of their songs, the weird wildness of their calls, the majesty of their soaring flight, and the mystery of their migrations always have been subjects of absorbing interest to poets, artists and lovers of nature. Prominent among the undying memories of men are mental pictures of the birds of childhood, their coming in the spring, their nesting and their chosen haunts. Many an exiled emigrant longs in vain to hear again the outpouring melody of the skylark, as it soars above the fields of England. Many a New England boy, shut in by western mountains, yearns for the bubbling, joyous song of the bobolink in June meadows. The characters and traits of birds, their loves and battles, their skill in home building, their devotion to their young, their habits and ways, — all are of exceeding interest to mankind. Birds have become symbolic of certain human characteristics, and therefore some common species have come to be so interwoven with our art and literature that their names are almost household words. What biblical scholar is not familiar with the birds of the Bible? Shakespeare makes over six hundred references to birds or bird

life. Much of our best literature would lose some of its charm and appeal were it shorn of poetic allusions to birds.

Birds often have inspired the poets. Bryant's lines "To a Waterfowl" and Shelley's "Skylark" each exhibit a phase of noble inspiration. These are but instances of the stimulating power exerted on the mind of man by the bird and its associations. Some of the grandest poems ever written have been dependent on their author's observations of birds for some touch of nature which has helped to render them immortal. Thus Gray, in his famed "Elegy Written in a Country Churchyard": —

> The breezy call of incense-breathing morn,
> The swallow twittering from the straw-built shed,
> The cock's shrill clarion, or the echoing horn,
> No more shall rouse them from their lowly bed.

Who, reared in a country home, can fail as he reads these lines to recall the twittering of the swallows under the spreading rafters in the cool of early morning? The mental contemplation of that peaceful scene, the train of tender recollections of the time of youth and innocence, all tending toward better impulses and higher aspirations, are largely due to the mention of the familiar bird in its association with the home of childhood. Is not literature the richer for the following lines of Longfellow, in his "Birds of Passage"?

> Above in the light
> Of the star-lit night,
> Swift birds of passage wing their flight
> Through the dewy atmosphere.
>
> I hear the beat
> Of their pinions fleet,
> As from the land of snow and sleet,
> They seek a southern lea.

How much of life and color the presence of birds adds to the landscape! The artist appreciates this. What marine view is complete without its sea birds in flight? How much of life and action a flock of wild-fowl add to a lake or river scene!

Birds are a special boon to child life, and a never-ending source of entertainment to many children who live upon isolated farms, where in summer or in winter the observation of birds adds greatly to the rational enjoyment of existence.

It is not a far cry from the poet to the philosopher, who also sees a value in birds for the opportunity they afford for the culture of the intellect. Every page of the book of nature is educational; but, as Dr. Coues says, there is no fairer or more fascinating page than that devoted to the life history of a bird. The systematic study of birds develops both the perceptive faculties and the analytical powers of the mind. The study of the living bird afield is rejuvenating to both mind and body. The outdoor use of eye, ear and limb necessitated by field work tends to fit both the body and mind of the student for the practical work of life, since it develops both members and faculties. The beauty and grace of birds appeal to the eye; their activity is inspiriting; their joyousness is contagious; and their finest songs awaken the spirit of praise and devotion. There is no purer joy in life than that which comes to those who, rising in the dusk of early morning, welcome the approach of day with all its bird voices. The nature lover who listens to the song of the wood thrush at dawn, — an anthem of calm, serene, spiritual joy sounding through the dim woods, — hears it with feelings akin to those of the devotee whose being is thrilled by the grand and sacred music of the sanctuary. And he who in the still forest at evening harkens to the exquisite tones of the hermit, — that voice of nature expressing in sweet cadences her pathos and her ineffable mystery, — experiences amid the falling shades of night emotions which must humble, chasten and purify even the noblest of the sons of men.

The uplifting influence that birds may thus exert upon the lives of men constitutes their greatest value and charm. A growing appreciation of the esthetic and the educational value of birds has sent many cultured folk to the woods, fields and shores. People are turning toward nature study, and the observation of birds in the field is one of the most popular manifestations of an increased and abiding interest in animate Nature. Students who have become familiar with the common birds of their own vicinity long for new fields and new birds.

Let a well-known writer describe in print any locality in Massachusetts where rare or interesting birds are to be found, and soon some of his readers will be upon the ground.

Possibly, however, the greatest boon that the study of birds can confer upon man is seen in the power of the bird-lover to keep his spirit young. One who in early years is attracted to the study of birds will find that with them he always renews his youth. Each spring the awakening year encompasses him with a flood of joyous bird life. Old friends are they who greet him, and they come as in the days of childhood, bringing tidings of good cheer. Years roll on, the days of youth are gone, the head becomes bowed with sorrow and frosted by the snows of time, the strong hand trembles, the friends of youth have passed away, — but each returning spring the old familiar bird songs come back to us, unchanged by the passing years. Let us, then, teach our children to love and protect the birds, that these familiar friends of their childhood may remain to cheer them with song and beauty when, toward the sunset of life, the shadows will grow long upon the pathway.

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